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CRITERIA FOR AIRLIFT ELEGIBILITY

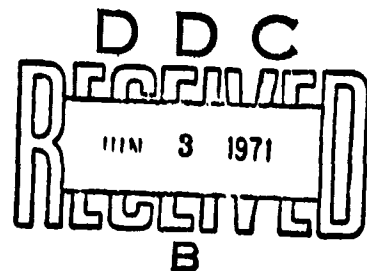OF DoD CARGO

TASK 70-19

LOGISTICS MANAGEMENT

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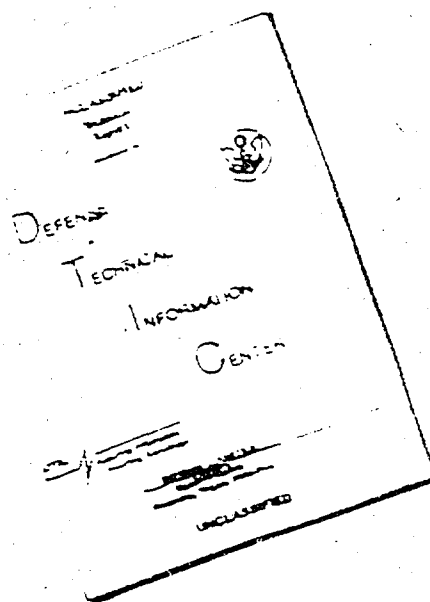
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CRITERIA FOR AIRLIFT ELIGIBILITY

OF DoD CARGO

TASK 70-19

May 1971

LOGISTICS MANAGEMENT INSTITUTE
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13. ABSTRACT

Under this task LMI considered new criteria for air shipment. Air shipment of items based on priority is not expected to generate all of the cargo which the growing Military Airlift Command (MAC) fleet will be capable of carrying within the peacetime flying hour program.

Easily applied economic air eligibility criteria for selecting intercontinental DoD cargo for airlift are needed by DoD. By use of such criteria DoD can make significant savings and cost avoidances—about $60 million in FY 1972—primarily because airlift is faster than sealift thereby permitting a reduction in inventory. Therefore, the more expensive the cargo that is airlifted, the greater the savings. Consequently, item price density—dollars per pound—is the best current criterion of air eligibility. More precise criteria are too complex for DoD-wide implementation now.

Items with a price density of $3.87 per pound or more should be airlifted overseas routinely with special exceptions. For example, items whose overseas depot reorder point is not responsive to actual order and shipping time, or whose inventory reductions would be at the expense of mobilization reserve stocks, should be routinely sealifted.

Adjustments to the criteria will be required to reflect actual experience. Therefore, the process of calculating economic criteria should be repeated annually.

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PREFACE

This is the final report on LMI Task 70-19, "Criteria for Airlift Eligibility of DoD Cargo." Air eligible DoD cargo is DoD cargo which may be airlifted in accordance with DoD policy. All other DoD cargo must be transported by surface.

Air eligibility of DoD cargo up to February 1971 was based on military priority because priority airlift demand during the Southeast Asia conflict exceeded military airlift capacity. Interest was stimulated in economic air eligibility because of the likelihood that in peacetime airlift priority cargo would be substantially less than airlift capacity, especially with the advent of the C-5. As a result, studies of the role of peacetime cargo airlift have been made by the Air Force, the Institute for Defense Analyses (IDA), and Research Analysis Corporation (RAC).

It is LMI's task to develop simple criteria to assist in implementing economic airlift eligibility policy, drawing upon the previous studies as appropriate. The objective of the policy is to minimize total DoD peacetime distribution costs for a given military posture. The task does not involve larger questions such as location of airports and seaports, or vehicle routing.

LMI reviewed the previous studies and examined the impact of airlift on DoD operations and the requirements for air eligibility implementation. Information and advice were obtained during the study from personnel in DoD, IDA, RAC, and commercial sources involved with DoD transportation. We wish to acknowledge their valuable assistance.

SUMMARY

Previous policy permitted airlift of DoD cargo which had high military priority. Priority requirements during the Southeast Asia conflict exceeded military airlift capacity, hence no other air eligibility criteria were considered necessary. However, as the Southeast Asia conflict phases down, priority is not expected to generate all of the cargo which the Military Airlift Command (MAC) fleet will be capable of carrying within the peacetime flying hour program required for essential training.

Under Task 70-19, LMI was requested to develop criteria for selecting for airlift the most appropriate categories of cargo from an overall DoD-wide cost effectiveness standpoint. LMI's study was confined to intercontinental shipments.

The use of economic air eligibility criteria will result in significant savings and cost avoidances--about $60 million in FY 1972--without adversely affecting mobilization material reserves. Even greater savings or cost avoidances can be obtained by FY 1975--perhaps $100 million per year--as the supply management system develops more fully, the MAC fleet reaches its full C-5 complement, and more data become available for refining the economic criterion.

Savings will be generated through the use of cargo airlift within the capacity of the flying hour program primarily for two reasons:

1. It is cheaper to move cargo by such airlift because the incremental costs to DoD are those relatively small costs of carrying cargo on partially full aircraft. Those incremental costs are less than sealift costs.

2. Airlift is faster than sealift which permits a reduction in the amount of stocks in the transportation pipeline.

Therefore, the more expensive the cargo that is airlifted, the greater will be the savings. Consequently, dollars per pound--that is, the replacement price of the item divided by its weight--is the best single, simple, reliable criterion of air eligibility. A more precise criterion--the difference in cents-per-ton-mile between airlift and sealift costs, taking into consideration inventory savings--is too complex for implementation now, even though efforts are already under way to apply such a criterion. Alternately, classification by groups is inaccurate because the range of item cost factors within each group does not permit reliable air eligibility classification of items. However, the criterion of dollars per pound will permit the recovery of 80% of the potential saving and cost avoidance theoretically possible with the more precise criterion, and it has the advantage of being simple enough to be applicable now.

For the fiscal year beginning July 1971, LMI recommends that all cargo which is about $3.87 per pound or more be declared air eligible. The $3.87 per pound figure results from our calculations which are described in this report and the Appendices. Any figure from about $3.75 per pound to $4.00 per pound is equally satisfactory as a criterion because of the uncertainty

in the data base. However, $3.87 per pound is the figure which emerged from the data values LMI used and hence we refer to it as the recommended figure.

Items which are air eligible under the $3.87 per pound criterion will be coded air mandatory—that is, routine overseas shipment of such items (outbound and retrograde) should be via airlift—unless there are special reasons why no saving would result if shipped by air. For example, since inventory savings represent the major portion of total savings, an item should not be coded air mandatory unless airlift will result in some inventory reduction. Items which are expected to be in a surplus position during the next year or have an overseas depot reorder point which is not responsive to actual order and shipping time should continue to be transported routinely by sea. Another special reason limiting the use of peacetime airlift is consideration of wartime or emergency requirements. Inventories should not be reduced at the expense of mobilization reserve stocks.

Retrograde capacity equals outbound capacity but retrograde cargo shipments total far less than outbound. Therefore, most retrograde items may be routinely airlifted with additional savings if administrative arrangements are convenient. The total savings in retrograde are relatively small (perhaps $9 million/ year). Therefore, it should be optional for each DoD component to designate airlift of retrograde items with a price per pound which equals or exceeds 75 cents.

Short shelf life items inherently have a higher storage cost than other items. Therefore, the air eligibility criterion for short shelf items should be modified on a graduated scale reflecting shelf life. The recommended values are tabulated in this report.

Adjustments to the criterion will be required subsequently to reflect actual experience and improved data on cost factors, requirements, and capacity. Such adjustments based on experience are the only way to take full advantage of the capacity generated by the flying hour program. Therefore, the process of developing and using economic criteria should be cyclic: Annually, OSD should issue the economic air eligibility criterion for the Services to use; they in turn should provide OSD with the data required for determining the criterion for the following year. The model which LMI used and the calculations in arriving at economic criteria and savings are described in the report and may be used by OSD for future calculations. The procedure is flexible and responsive to changes. Periodically, the data supporting the procedures should be reappraised and refinements introduced.

An implementation plan is included in this report to show that the economic airlift eligibility criterion can be adapted to existing DoD procedures and to show how it might be phased in. There are several DoD Directives and Instructions that need to be modified to fully use the economic air eligibility criterion. DoD Directive 4500.9, "Transportation and Traffic Management," needs to include a DoD policy statement concerning the economic air eligibility criterion. The Uniform Materiel Movement and Issue Priority System (UMMIPS), DoD Instruction 4410.6, must be modified. References to DoD Directive 4500.9 should be included in provisioning and supply documents. Documents concerned with transportation challenges should be revised to reflect the new criterion. Proposed changes to the documents are included in this report.

LMI's suggested criterion of $3.87 per pound is based on the mid-points of many data with large uncertainty. Therefore, we have calculated the potential airlift savings using a wide range in input data. In all cases, it appeared that substantial savings can be obtained, justifying implementation of economic air eligibility. While there is no question about the desirability of economic air eligibility, the precise criterion still is uncertain, and it is doubtful if a significant improvement in the criterion can be calculated without the experience gained from implementation. Moreover, it would not pay to postpone implementation and the immediate savings likely while continuing the search for a refined criterion that would make it possible to achieve a small additional portion of the total potential benefit.

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GLOSSARY

ACL	Allowable Cabin Load
AFLC	Air Force Logistics Command
APOD	Aerial Port of Debarkation
APOE	Aerial Port of Embarkation
CONUS	Continental United States
FSC	Federal Stock Class
FSN	Federal Stock Number
ICP	Inventory Control Point
IDA	Institute for Defense Analyses
JCS	Joint Chiefs of Staff
MAC	Military Airlift Command
MACA	Military Airlift Control Agency
MSC	Military Sealift Command (Formerly Military Sea Transportation Service (MSTS))
MT	Measurement Ton (40 Cubic Feet)
MTM	Measurement Ton-Mile
MTMTS	Military Traffic Management and Terminal Service
O/S	Overseas
O&ST	Order and Shipping Time
POD	(Sea) Port of Debarkation
POE	(Sea) Port of Embarkation
RAC	Research Analysis Corporation
RDD	Required Delivery Date
ROP	Reorder Point
SDD	Standard Delivery Date
SSCO	Service Shipping Control Office

GLOSSARY (cont'd.)

ST	Short Ton
STM	Short Ton-Mile
TCMD	Transportation Control Movement Document
UMMIPS	Uniform Materiel Movement and Issue Priority System
WSEG	Weapons Systems Evaluation Group

I. INTRODUCTION

On 18 March 1970 the Assistant Secretary of Defense (Installations and Logistics) asked the Logistics Management Institute (LMI) to undertake Task 70-19, "Criteria for Airlift Eligibility of DoD Cargo."[1] This document is the final report on that task. The Introduction discusses: (a) the purpose of the task, (b) the background of the subject, (c) the scope of the LMI effort, (d) the study approach used, (e) a description of the present distribution system as it pertains to air eligibility, and (f) the organization of the remainder of the report.

A. PURPOSE

The task is oriented toward developing rules for determining whether goods shipped routinely overseas during peacetime by the Department of Defense (DoD) should move by air or surface transportation. Task Order 70-19 recognizes that airlift capacity is increasing because of the entrance of the C-5 aircraft into the DoD inventory. The task order also states that current policy may not provide the basis for the most economic use of the DoD transportation capability; that is, the present criterion for determining airlift eligibility deals primarily with priority of need.[2] Inventory reductions and other distribution system cost savings were not considered previously. Therefore, LMI

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[1] A copy of the Task Order is included as Appendix 1.

[2] DoD Instruction 4410.6, "Uniform Material Movement and Issue Priority System (UMMIPS)," 24 August 1965. The February 1971 revision allows for airlift on an economic basis. However, a procedure for determining the economics of airlift is not spelled out there or in any other regulation.

was requested to examine all categories of peacetime DoD cargo
which might be candidates for airlift and to develop criteria
for choosing the mode of shipment from an overall, DoD-wide
cost/effectiveness standpoint.

B.   BACKGROUND

The large surge in the overseas demand for supplies during
the last five years has put great pressure on the nation's inter-
continental transportation system. Early in the Vietnam war,
cargo was moved primarily by ship because the capacity of airlift
was limited and was being used for passengers and top priority
cargo. Capacity increased substantially with the introduction of
the C-141 aircraft and the greater utilization of commercial air-
lift. No C-141s were in use in 1965, but 234 were in use in 1969.
Commercial airlift expenditures increased from $214 million in
1965 to a peak of $605 million in 1967 with $551 million in 1969.[1]
However, even with the increased airlift capacity, the amount of
overseas cargo requirements was so large that not all top pri-
ority cargo was airlifted. Many high priority shipments normally
eligible for airlift had to be diverted to sealift. To further
insure that the available airlift was used efficiently, a review
system was instituted to "challenge" shipments as to their
appropriateness for airlift.

Reductions in overseas military requirements are beginning
to change the airlift situation. Withdrawal of U. S. forces
from Vietnam and the lessening of combat activities there have
reduced the demand for movement of personnel and material to the

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[1]Hearings before the Subcommittee on Military Airlift of the
Committee on Armed Services, House of Representatives, 91st
Congress, 2nd Session, HASC 91-51, p. 6508.

area. The national approach of a "low profile" elsewhere in the
world is reducing the number of geographic areas to be supplied
as well as the size of the peacetime forces maintained overseas.
The result is a diminishing demand for intercontinental trans-
portation by the DoD.

Airlift capacity, on the other hand, is growing. The C-5
aircraft will provide more than enough airlift to meet peacetime
priority airlift requirements.

The purpose of MAC organic airlift capability is to trans-
port combat forces and their material and supplies during hos-
tilities. To perform this function, the airlift forces must be
maintained in a high state of readiness because delays encountered
by moving combat forces by ship, or during mobilization of a moth-
balled airlift force, would not be acceptable during a contingency.
To maintain a high state of readiness the airlift forces must fly
enough to train the flight and maintenance crews, and cargo must
be airlifted to train the aerial port personnel. This flying
program will, as a byproduct, generate over 2 billion ton-miles
of cargo capacity in FY 1972.[1] The use of that capacity to move
peacetime cargo provides an opportunity to reduce DoD's overall
distribution cost.

This last point has been recognized by the OSD and the
Services. Several studies have been, or are being, made to
determine what items can be shipped economically by air, con-
sidering inventory reductions and other distribution cost savings.

A recent study by the Institute for Defense Analyses (IDA)
developed broad guidelines regarding policies and procedures to
take maximum advantage of intercontinental transport capabilities

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[1] Calculations are given in Table 3-6.

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of the mid-1970's.[1] Airlift and sealift costs were developed through the application of cost analysis techniques using official financial and program documents.

The Research Analysis Corporation (RAC) efforts were initiated in 1965 in support of the Office of the Deputy Chief of Staff for Logistics, Department of the Army.[2] RAC's initial study concentrated on the cost data and cost model. A 1969 RAC report documented the procedures, resulting estimates of the air ton-mile demand, and the savings if all economically air-eligible commodities were airlifted. A follow-on study has improved the formulas and the data used to select items for airlift based on economics.

The Air Force has examined the economics of transporting cargo within the framework of their Airlog 70 study program.[3] Their study provided an insight into the relative importance of various distribution cost elements. About one-half the tonnage shipped to overseas Air Force activities was found to be air eligible.

The completion of the prior studies demonstrated the value of the concept of economic air eligibility. Accordingly, it was requested that LMI, using the previous studies as a foundation, develop an appropriate criterion for the Services to use in designating cargo for air shipment.

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[1] R. F. Stryker, et al., Resupply in Peace and War by C-5 Airlift and by Containership, July 1969, IDA/WSEG Report 141.

[2] This is a continuing effort. A report has been published: Lawrence G. Regen, et al., Economic Use of Military Airlift and Sealift for Overseas Shipment in Peacetime, January 1969, Research Analysis Corporation Report 64 (RAC-R-64). The follow-on effort is reported in Selection of Items for Air Shipment on an Economic Basis, Research Analysis Corporation Report 116 (RAC-R-116), February 1971, Ray M. Clarke, et al.

[3] The Economics of Cargo Shipment, Airlift versus Sealift, Air Force Logistics Studies, Airlog 70 Phase III Report, January 1969, Air Force Logistics Command (AFLC).

C.   SCOPE OF LMI EFFORT

The LMI task is oriented to that portion of the overall distribution system concerned with intercontinental transportation. It is on that leg of the distribution system that airlift offers the principal cost reduction opportunity. The transportation time on the continental leg is too short to permit the difference between surface and airlift to be translated into cost reductions within the scope of the current task.

The primary mission of the airlift forces of DoD is to be ready to move combat forces whenever and wherever necessary in the world. Therefore, for this task, we have assumed that the size of the MAC fleet and its flying hour program has been predetermined. Once those decisions are given it is only necessary to examine how to utilize the resulting resources in peacetime to move DoD cargo.

The DoD system for procuring, storing, requisitioning, issuing, transporting, and receiving material is very complex. Also, elements of the system vary greatly in their sophistication and method of responding to changes. Criteria for air eligibility while primarily concerned with transportation, influence many parts of the distribution system. It is beyond the scope of the study to treat the whole distribution system. As a result, it is necessary to work with the distribution system as it exists, initially modifying as little as possible to implement air eligibility criteria. Therefore, this study does not deal with: (a) opportunities to improve the distribution system in other ways, such as revised vehicle routing, CONUS air haul, containerization, expedited order processing, direct vendor shipments, etc., nor with (b) daily traffic management problems.

There are two advantages to this narrow scope: first, there
may be cost savings using overseas airlift which can be obtained
immediately under existing procedures without waiting for a
solution to other problems. Second, construction of a comprehen-
sive model embracing all the other issues would take well beyond
the time frame of the LMI task and may be beyond the present
state-of-the-art.

A decision model for air eligibility must be able to interact
with other elements of the distribution system if it is to remain
useful as the other system elements improve. The model we pro-
pose has that necessary property--it can assist evaluation of
the distribution system and it can respond to changes in the
system. For example, outputs from the model may be used to assist
in estimating:

1. the value of a day saved anywhere in the system,
    such as waiting for transportation,

2. the amount of money that could be spent to improve
    efficiency and still not increase overall DoD
    costs, and

3. the value of alternative inventory policies and
    procedures.

Improvements in any of those three areas would in turn affect
cost factors which are inputs to the model.

The use of commercial airlift instead of, or in conjunction
with, military airlift is relevant in the general discussion of
DoD airlift of cargo. The task order does not require us to
address this complex question in depth, but rather that ". . .
appropriate consideration will be given to: c. Most efficient

use of military airlift capacity and extent of use of commercial airlift." In fulfillment, we present in Section V a discussion of several possible "rules" for defining a split between commercial and military airlift of DoD cargo and the adaptability of the proposed criteria to such rules. We do not recommend a specific rule; we only show that the air eligibility criteria can accept and adjust to a rule.

D.   STUDY APPROACH

As mentioned earlier, there has been considerable study of criteria for determining the mode of transportation for overseas cargo. Some of the criteria investigated were simple administrative rules which did not necessarily depend on economics, while others were based on economics but were applied to a part of the distribution system. Understanding those criteria and their pros and cons was the first of five study steps.

The next step was to look at the practices of the military services in: (a) transportation organizations--Military Airlift Command, Military Sealift Command (MSC),[1] Military Traffic Management and Terminal Service (MTMTS); (b) inventory management; and (c) financial aspects of transportation. An understanding of those areas is necessary to be able to develop criteria that will be practical and meet the DoD objective of cost effectiveness.

The third of the five steps was to develop a theory upon which the criteria could be based. The theory may never be visible to supply and transportation personnel using the criteria, although understanding it is vital to the acceptance of the criteria.

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[1] MSC was formerly Military Sea Transportation Service (MSTS).

Step four involved the development of an implementation plan for reducing the criteria to practice. The plan had to:

1. Be practical. It must permit and encourage the use of the criteria by the personnel performing the supply and transportation functions.

2. Provide feedback. OSD and the Services must know how cost/effective the criteria are.

3. Be timely. Values of the criteria must be based on current or very recent data to provide a useful tool for the next time period or cycle.

The final step in the LMI approach was to examine the impact of the proposed air eligibility criteria in specific transportation and supply areas.

The investigation of air eligibility requires considerable data not only on transport systems, but also on the cargo to be shipped. Data on the demands placed on transportation must:

1. represent peacetime operations,

2. include all cargo shipped,

3. cover a sufficient period to remove seasonal variations, and

4. be detailed to the degree that different criteria could be analyzed and differences in the results noted.

Considerable effort during previous studies was devoted to collecting transactions and other data. None of the data were really representative of future peacetime years. LMI selected

the 1965 data base developed by RAC[1] as being most convenient.
That data base contains overseas demands for Fiscal Year 1965.
While the age of the data base may raise questions as to its
appropriateness for making decisions affecting the 1970 decade,
it is the most recent year for which peacetime demand and cata-
log data are available for analysis.[2]

Therefore, that data base is considered sufficient for de-
veloping the initial criteria for implementing economic airlift.
It is recognized that the data base is not representative for
subsequent calculations of the criteria. As a result, the imple-
mentation plan we propose provides for using more current data
for the determination of subsequent years' criteria values.

E.   DESCRIPTION OF CURRENT SYSTEM

The following paragraphs describe the DoD distribution
processes relevant to criteria for economic air eligibility of
cargo. The description is limited to requisitions originating
overseas for routine resupply (in contrast to those involving
urgency of need). Time standards for the performance of the dis-
tribution processes are listed in UMMIPS.[3]

1.   A requisition for goods is submitted by an overseas
depot or base to the Inventory Control Point (ICP) managing those
goods. The time of the requisition and the quantity requested
are based on guidance from the theater commander and the ICP con-
cerning, among other things, safety stocks to be maintained, the
order and shipping times (O&ST), reorder point (ROP), and the
financial situation. The requisition contains the Federal Stock

[1] L. Regen, op. cit., Volume I, Chapter 3.

[2] Ibid., Volume 2, p. 161, Figure E1.

[3] Op cit., Inclosure 2, p. 4.

Number (FSN) of the item desired, and the UMMIPS priority desig-
nator and the standard or required delivery date in accordance
with UMMIPS. The requisition is submitted to the ICP for action.

2.   Upon receipt, the ICP checks the inventories of the
item to determine the proper source for filling the requisition.
It then issues a release order to a stock point to pack and ship
the goods.

Periodically, the worldwide inventories are reviewed
to the extent possible by the ICP to determine if there are ex-
cess stocks anywhere that need to be transferred or if there is
a need to procure more inventory. The decisions of when to buy
and how much to buy are based not only on the stocks on hand in
depots but also on the amount of stocks that are in transit from
CONUS to overseas depots.

3.   The CONUS depot receiving the release order checks it
for completeness and correctness, notes the required delivery
date and determines the mode of transportation to be used. The
depot packs the requested quantity and sends advance documentation
on the shipment to its military service clearance office.[1] When
the shipment is approved by the clearance office, the depot ships
the goods to the appropriate port.

4.   The clearance offices of the military services examine
the documentation on shipments (especially shipments to be trans-
ported via air) to determine the appropriateness of the quantity,
the transportation routing including mode of transport, size of
the item, weight, density, and requisition age. If the shipment
was routed for airlift, but fails to meet challenge criteria,

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[1]The military service clearance offices include the Naval
Transportation Coordinating Offices, the Air Force Cargo Manage-
ment Division, and the Army Logistics Control Offices.

the clearance office reroutes it for surface (ship) movement. One of the challenges that an air-designated shipment must meet is whether the required delivery date can be met using surface transportation. If so, it will be diverted. Finally, the goods reach the requisitioner and are issued as needed.

F. ORGANIZATION OF THE REPORT

The report is organized as follows:

1. Section II, _Theory for Economic Air Eligibility Criteria_, provides the basis from which the criteria are developed.

2. Section III, _The Criterion_, presents the criterion to be used, and discusses the need to reevaluate the criterion value as conditions change.

3. Section IV, _Implementation Plan_, describes: (1) how the proposed criterion can be put into use and who will be involved, and (2) the feedback system required to keep the criterion viable over time.

4. Section V, _Impact of Criterion on Related Topics_, presents separate discussions on a variety of topics related to the distribution system and air eligibility criterion.

5. Section VI, _Recommendations_, summarizes those actions that LMI believes should be accomplished.

6. The appendices contain derivation of the formula, description of the model, calculations of the criterion, data requirements and drafts of proposed policy statements.

For those who must make the decision concerning the criterion, Sections III, IV and V will be most valuable. For those who put the criterion into practice, Sections III and IV provide the necessary information. For those personnel charged with programing

and supervising the analytical procedures, the appendices are the most important parts of this report.

II. THEORY FOR ECONOMIC AIR ELIGIBILITY

This section presents the theory for use of the inter-
continental airlift resource to carry cargo during peacetime.
The theory consolidates previous analyses of peacetime economic
air eligibility with provisions to factor in quantitative re-
lationships of mobilization material requirements and other war-
time considerations. First, we discuss the objective of economic
air eligibility and the necessary underlying assumptions. Then,
in several subsections covering costs and war requirements, we
derive the theory for optimum economic use of intercontinental
transportation resources. Finally, we illustrate the calcula-
tions of the DoD costs for selected amounts of airlift. It can
then be seen that the potential savings from peacetime use of
airlift are substantial.

A. OBJECTIVE OF ECONOMIC AIR ELIGIBILITY

The objective of economic air eligibility rules or criteria
is to provide transportation mode classification for overseas
cargo which minimizes total DoD costs in peacetime while satis-
fying military requirements. The principal intercontinental DoD
cargo airlift element is the MAC fleet. The primary mission of
MAC is rapid deployment of combat and support forces in time of
emergency. In order to respond to emergency requirements, MAC
must exercise its airlift forces on worldwide logistic support
routes during peacetime. This exercise, called the peacetime
flying hour program, generates cargo-carrying capacity as a by-
product.

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Some of this peacetime cargo-carrying capacity is required and used under existing procedures. For example, there are priority requirements in peacetime, as when a key unit in the field is short of some supply item. Also, there are special military missions and airborne troop exercises which use some of the airlift capacity. We presume that all such military requirements are primary and that airlift space will continue to serve such requirements first, as in the past. Thereafter, if space is available, economic considerations should determine to what extent the otherwise unused capacity should be used. Complete utilization of the MAC capacity generated by the flying hour program may not be prudent, despite the appeal of putting cargo on partially filled MAC aircraft. The criteria to be developed must provide a simple test for each item to be shipped overseas so that if all items are shipped in accordance with the criteria, DoD costs will be minimized without degrading mobilization reserve or priority requirements.

B. FORMULA FOR DISTRIBUTION COSTS

An essential step in the economic analysis is the determination of DoD costs for intercontinental airlift and sealift for identical requirements. Accordingly, this subsection lists the cost elements, discusses the degrees of aggregation appropriate and presents the resulting formula. The formula is not new or significantly different from others available. It was used to explore points not considered in prior studies.

1. Cost Elements

The relevant cost elements are:[1]

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[1] A more detailed breakdown is given in Appendix 2.

a.   Packing

b.   Inland Haul (CONUS and Overseas)

c.   Port Handling

d.   Intercontinental Haul

e.   Inventory

Packing costs are those costs involved in preparing an item (which may already be packaged) for shipment from a CONUS depot or warehouse to an overseas location. The costs include those of crating, weatherproofing, or blocking; or the costs for a carton for an item; or some prorata cost of a container. The type of packing, and hence its cost, may depend on the anticipated shipment mode or upon the storage conditions required overseas.

Inland haul covers the cost of movement from the CONUS depot or warehouse to the APOE or POE, and the cost for the overseas inland or local leg, i.e., from APOD or POD to either the overseas depot or the first destination field activity.

Port handling costs include the terminal and warehousing costs and port handling costs at APOE, POE, APOD, and POD.

Intercontinental haul costs include either the line haul costs for the ocean vessel or for the aircraft.

Inventory costs are those one-time costs associated with the purchase of stock for overseas depots and the transportation pipeline which supports those depots, as well as the annual holding costs for such stock.

2.   Aggregation

Costs can be calculated by different degrees of

aggregation. The distribution costs for the items shipped over-seas include all the costs for each element described above, applied individually to each item each time it is shipped. A determination of such costs in complete detail would be impractical, particularly if we consider collecting the data for each cost element for each item. This determination can be simplified by aggregating in several ways, including (1) the items may be put into material classes or groups for which cost elements are presumed to be homogenous; (2) the cost elements may be aggregated or averaged--for example, intercontinental haul costs may be averaged and the same rate applied regardless of origin and destination; or (3) the variation of costs over time may be smoothed, for example, by amortizing the stock purchases.

LMI chose to aggregate the items by federal stock classes because the inaccuracies in developing the total costs and criteria were not significant. Subsequent transportation mode classification of items within a class cannot rely on aggregated factors because of the variance. This complication does not affect the calculations in Section III.

3. The Formula Used

Distribution costs are related to distance, mode, volume, weight, item price and commodity classification.[1] We have assumed the relationships are linear except for commodity classification which was omitted because the resulting error appeared negligible. We have also assumed that sea packing and port handling costs depend on volume only while air packing and port handling costs depend on weight only. Inland haul

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[1] A more detailed rationale appears in Appendix 2.

costs have also been omitted since the difference between the inland costs associated with airlift and those associated with sealift appeared insignificant.

The resulting formula was applied to each Federal Stock Class (FSC) to determine the DoD distribution cost if air-lifted, C_{TA}, and the cost if sealifted, C_{TS}:

$$C_{TA} = C_{PA} \times W + M \times C_A \times \max\ (W,\ V/200\ \text{cu.ft. per ton}) \quad (1)$$

$$C_{TS} = C_{PS} \times V + M \times C_S \times \max\ (W,\ V/40\ \text{cu.ft. per ton})$$

$$+\ I \times \Delta t \times P \quad (2)$$

where:

C_{PA} = Air Packing and Port Handling Cost, \$/ton

W = Weight of Items, tons

M = Length of Intercontinental Shipping Distance, miles

C_A = Airlift Rate, \$/ton-mile

V = Volume of Item, cubic feet

C_{PS} = Sea Packing and Port Handling Cost, \$/cubic foot

C_S = Sealift Rate, \$/measurement ton-mile

I = Cost to Hold and Amortize Item, % of item price/year saved by airlift

Δt = Time Saved by Airlift, fraction of a year

P = Price of Item, \$

Development of the formula was relatively easy in view of the previous studies by RAC, IDA, and AFLC. Determination

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of the appropriate data to use in the formula, however, is not straightforward. For example, information available on the cost factors varies widely. In fact, the largest single cost saving depends on inventory reduction, and inventory plays a vital role in war as well as in peacetime. So, we turn next to war requirements and their relationship to inventory.

C. WAR REQUIREMENTS

Since peacetime inventory may become wartime assets, the role of both peacetime and wartime inventory must be considered before choosing airlift because of potential reductions in the peacetime pipeline. Inventory exists at several points in the distribution system--in CONUS and overseas depots, in CONUS and intercontinental pipelines--both in wartime and peacetime. For some items, a reduction in peacetime inventory in the intercontinental pipeline would reduce the amount of inventory available in wartime without making any reduction in the requirement for that inventory in wartime. For example, there is a mobilization reserve material requirement for bombs both to fill the wartime sealift pipeline and because the rise in requirements immediately after D-Day exceeds the start-up capability of the factories.[1] Reduction in the peacetime inventory of such items

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[1] The total material required to support planned mobilization (including assets on hand if any) is called "mobilization material requirement" by JCS. The difference between this requirement and the material required for peacetime, is called "mobilization reserve material requirement" by the JCS and the Army, "war readiness material" by the Air Force, and "war reserves" by NATO. References, Dictionary of United States Military Terms for Joint Usage, Joint Chiefs of Staff, Pub. 1, December 1964; Dictionary of United States Army Terms, Headquarters, Department of Army, AR 320-5, April 1965; and Air Force Glossary of Standardized Terms and Definitions, Department of the Air Force, AFM 11-1, January 1967.

through use of peacetime airlift would not reduce the mobilization material requirements if sealift is the routine transportation mode in wartime. Consequently, the inventory benefits of fast transportation would be lost.

On the other hand, no mobilization stocks are required for some items because of the availability of a large commercial source. In such cases, reducing the peacetime inventory by use of airlift would not reduce wartime responjiveness. Therefore, such reductions should be made in peacetime if economical. An example of a hypothetical product in this category might be illustrated as follows:

	Requirement in Units if Peacetime Shipment is by:	
	Sea	Air
Pipeline	40	5
Safety stock for normal peacetime demand and delivery variation	30	30
Safety stock for pipeline interruption during contingency	<u>30</u>	<u>45</u>
Total	100	80

In practice, many factors influence requirements and assets, viz., ratio of usage in war vs. peace, variability in demand and delivery, whether adequate mobilization reserve material exists, multi-echelon vs. single echelon depots, availability of airlift in wartime[1], nature of industrial sources,

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[1]Cf. RAC-R-116, p. 11, where it is stated that wartime airlift be guaranteed for whatever items have been "budgeted for and procured on a normal air movement concept." In the IDA/WSEG 141 Report, Vol. 1, p. 67, such a plan is considered too risky.

whether the peacetime operating stocks are the only assets allowed, and the possibility for safety stock reduction through availability of airlift to correct shortages.[1] The situation is too complicated to permit easy generalization, especially with limited data on the proportion of items influenced by each of the factors listed above. Further study is warranted but is outside the scope of the current task.

In wartime after deployment it is expected that the MAC flying hour program would be 8 to 10 hours per day, equivalent to an expansion of annual outbound cargo capacity to about 4 billion ton-miles, including the full complement of C-5's. Airlift priority cargo requirements during the Southeast Asia conflict exceeded 4 billion ton-miles in FY 1968.[2] Assuming these figures as typical, there would probably be little residual capacity dependable enough for planning routine resupply in wartime after deployment.

Consequently, the peacetime economic benefits appear attractive enough to risk the uncertainties of supply in war only for the items with the most payoff. A significant number of such items probably can be economically airlifted in peacetime without reducing wartime capacity or readiness. Also, a significant number of items probably cannot be airlifted with appropriate inventory reductions without undue risk. Therefore, until further study clarifies the wartime situation, it appears prudent to calculate the economic air eligibility criteria on conservative assumptions, namely, not all of the peacetime capacity available should be committed to routine airlift.

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[1] Ibid., pp. 155-156.

[2] Much cargo with UMMIPS priority 04-08 was diverted from airlift because of inadequate airlift capacity.

If full use is desired by OSD, and corresponding inventory re-
ductions made, small additional savings will accrue, but at
an increased risk of shortages in war.

IM1 calculations have been based on the assumption that
some quantitative portion of the peacetime airlift capacity
can be identified as available in wartime for routine resupply
after initial deployment. That portion has been arbitrarily
chosen based on the ratio of material usage in peacetime to
that in wartime. Estimates show the ratio to be about 40%.[1]
Use of the ratio will be described in more detail later.

D.   CALCULATIONS OF DoD COSTS vs. AMOUNT OF AIRLIFT CARGO

To determine the cost data for use in formulas (1) and (2),
page 17, one must be able to estimate DoD cost changes caused
solely by changes in the amount of airlift cargo. The cost
changes may or may not be identical to price or charges. For
example, the cost to the DoD of ocean shipping in commercial
hulls equals the charge or price. However, the MAC fleet flies
channel routes to be ready for a contingency. Such flying costs
the DoD little more if the planes carry cargo, regardless of
the tariff charged.

The difference between tariff charges (which transfer money
from one DoD component to another) and DoD costs is worth de-
tailed explanation.

1.   Air Tariff and Costs

In previous studies tariffs have been used to calcu-
late air eligibility criteria. However, the tariff decreases
as cargo volume rises, whereas the incremental airlift cost
does not decrease as cargo volume rises.

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[1]See Table 3-3.

The incremental cost of carrying one more ton-mile of cargo on a MAC aircraft which must fly a channel route for readiness purposes includes such nominal costs as extra fuel and extra wear on tires. These nominal incremental costs apply to the capacity generated by the flying hour program. Once that capacity is exceeded an increment of air cargo will cost DoD considerably more per ton-mile because such cargo will create the need to schedule aircraft in addition to those used in the flying hour program. Accordingly, the cost to DoD of airlift cargo is a non-decreasing function as shown on Figure 1.[1]

The airlift tariff maintains the liquidity of the air-lift industrial fund. That fund finances some of the operating charges of the flying hour program which are relatively inde-pendent of cargo volume as indicated above. Accordingly, as cargo volume increases, the share of costs for each cargo incre-ment decreases and hence the tariff also decreases, as shown on Figure 1. Thus it appears that the tariff should not be used to calculate total DoD costs or to determine air eligibility.

2. Total Distribution Costs

Table 1 (foldout page 31) lists some estimated DoD costs incurred by the airlift and sealift systems for selected splits of cargo between the airlift and sealift systems. Costs include the cost elements listed in Subsection II.B.1. (p. 15) as well as relevant military readiness costs. For inventory costs only the differences were computed. For inland haul costs, analysis of the RAC study indicates the difference is negligible

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[1]The figure is based on calculations in Appendix 3 (pp. 10 and 11 and Table 3-25).

FIGURE 1. ESTIMATED INCREMENTAL
AIRLIFT COST & TARIFF
FOR JUNE 1971

ECONOMIC AIRLIFT CARGO VOLUME
AIRLIFT TON-MILES (Billions)
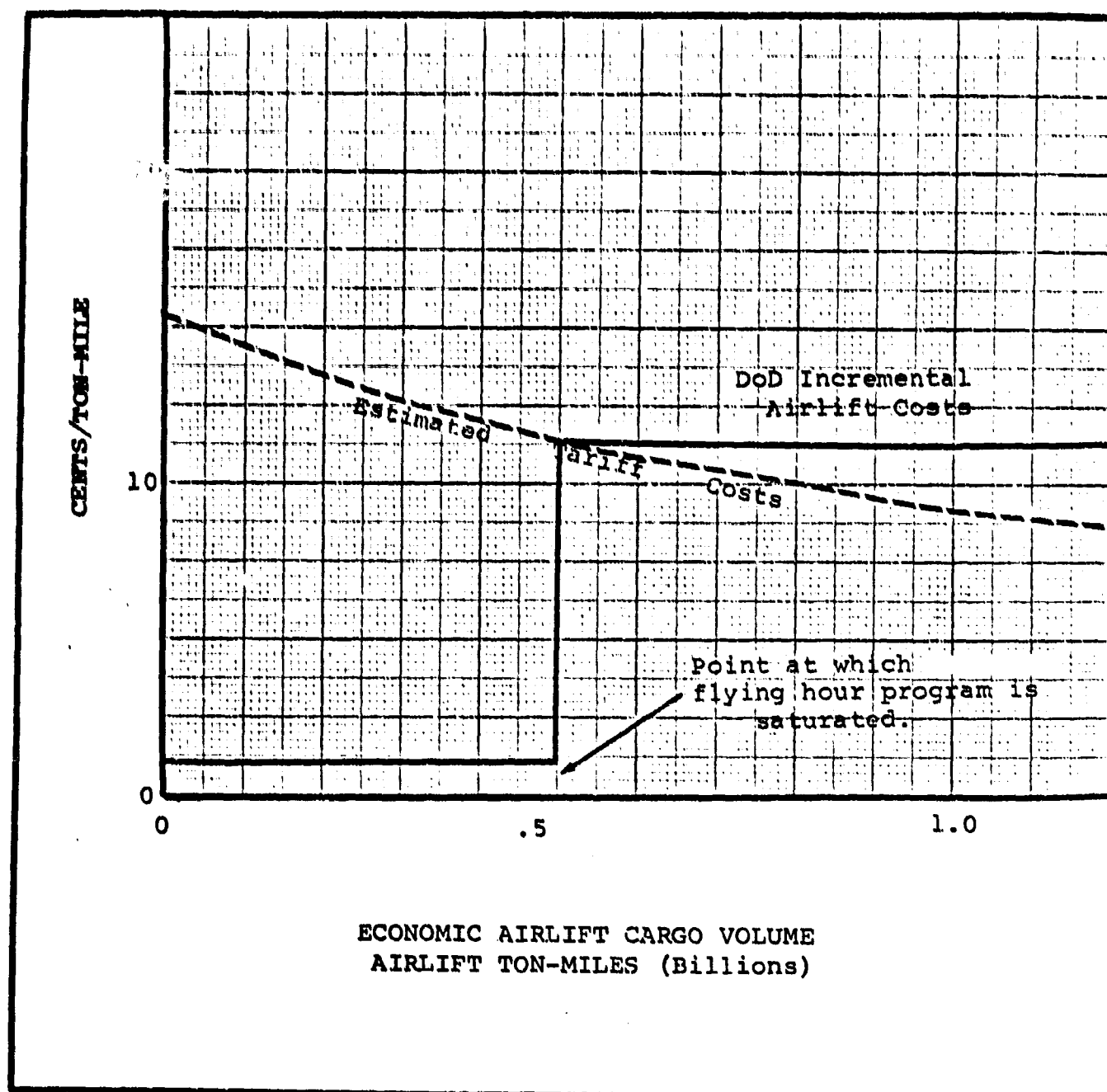
so it has been ignored in our calculations.[1]

The estimated costs are based on analysis of available data.[2] Because of the uncertainty in the data, the tabulated costs are also uncertain and continued use of these costs should not be made. Verification and regular recalculation in later periods are recommended, as discussed later.

Table 1 presents the costs in the airlift and sealift system for a different airlift-sealift cargo split on each line of the table. The first column represents the revenue cargo in short ton-miles in the airlift system, not including priority cargo. The second column lists the balance of the expected total cargo in measurement ton-miles[3] which would be in the sealift system.

The third column shows estimated airlift system costs, and includes military salary and fuel for the flying hour program plus packing, port handling, additional fuel, and related costs for the revenue cargo carried.

The fourth column shows estimated sealift costs, and includes packing, port handling, and intercontinental (ocean vessel) costs and <u>the cost of extra inventory for the longer sea pipeline</u>. The costs of extra inventory include provision for amortizing the one-time cost increase caused by purchase of extra inventory as well as the annual holding costs for the extra inventory. For the period considered, it is assumed that because of the asset position or the nature of the overseas (O/S) inventory management system, the pipeline would not be

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[1]Regen, <u>op. cit</u>., pp. 52-53.

[2]Details of the analysis are presented in Appendix 3.

[3]Measurement ton is a volumetric measure of 40 cubic feet of cargo. The nautical mile is used throughout.

shortened for 50% of the items.[1]

The total revenue cargo was assumed to be 18 billion short ton-miles (34 billion measurement ton-miles) per year. The 18 billion figure is based upon an examination of various projections for the peacetime period following the Southeast Asia conflict.[2] The distribution, or nature of items shipped, was based upon the RAC 1965 data base.

If we assume the MAC fleet in June 1971 contains 224 C-141s and 27 C-5s, and a 4½ hour flying program, the available capacity is about 500 million short ton-miles, after allowance for priority traffic, special missions, circuitous routings, etc. If no cargo, other than priority, is carried in the system, the cost of flying the MAC fleet in its flying hour program, including military salaries, training, fuel, etc., is $285 million per year. The average intercontinental sea line haul rate is about one-half cent per measurement ton-mile. That cost, plus packing, port handling, and additional inventory costs result in a sealift system cost of $507 million per year if only priority cargo is diverted to airlift. Total DoD costs, including sealift costs, are $792 million per year.

If economic cargo is introduced into the airlift system beginning with that which can benefit the most, i.e., that able to pay the highest air fare and still break even, overall DoD costs begin to decline as shown in the second row of Table 1. The principal savings (73% of total savings) result from inventory reduction. The value of this reduction has been based upon: the estimate that the annual inventory cost (including

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[1]The sensitivity of air eligibility criteria to this and other assumptions is discussed in Appendix 3, Section C.3.

[2]See Table 3-1, Appendix 3.

amortization) is 35% of the price of the item, a 30-day reduction in transportation time, an assumption that 50% of the items in this period of time are actually in a buy or repair position and would respond to reduced O&ST, and allowances for inventory savings only for those items which could be flown in wartime as discussed in Subsection C. That is, during routine resupply in war, following the initial mobilization, we have assumed that the volume of cargo would be approximately two-and-one-half times that in peacetime, and that the wartime residual capacity would be filled by economically ranked cargo. Therefore, only 40% of the residual peacetime flying hour capacity can be devoted to items for which there are inventory savings. The incremental cost to transport this cargo on aircraft already partially filled with priority cargo is slightly under one cent per short ton-mile.

Next consider filling the entire flying hour program capacity, 500 million STM (line 3 of Table 1). Notice the total DoD cost has declined to $731 million resulting in a total savings of $61 million (compared with no economic airlift cargo).

Consider finally the diversion of two billion short ton-miles into the air system (line 4 of Table 1). The costs are still decreasing in the sea system, but are increasing at a faster rate in the air system. Therefore, we have passed the cargo split with the minimum cost.

The total DoD distribution costs shown in column 5 of Table 1 are plotted in Figure 2 as a function of airlift volume. Here it also is evident that the minimum DoD cost occurs at about 500 million ton-miles. To the right of minimum cost point the airlift cost increase per unit of additional cargo exceeds the sealift cost decrease per unit of additional

FIGURE 2. TOTAL DoD DISTRIBUTION COSTS vs. AIRLIFT VOLUME
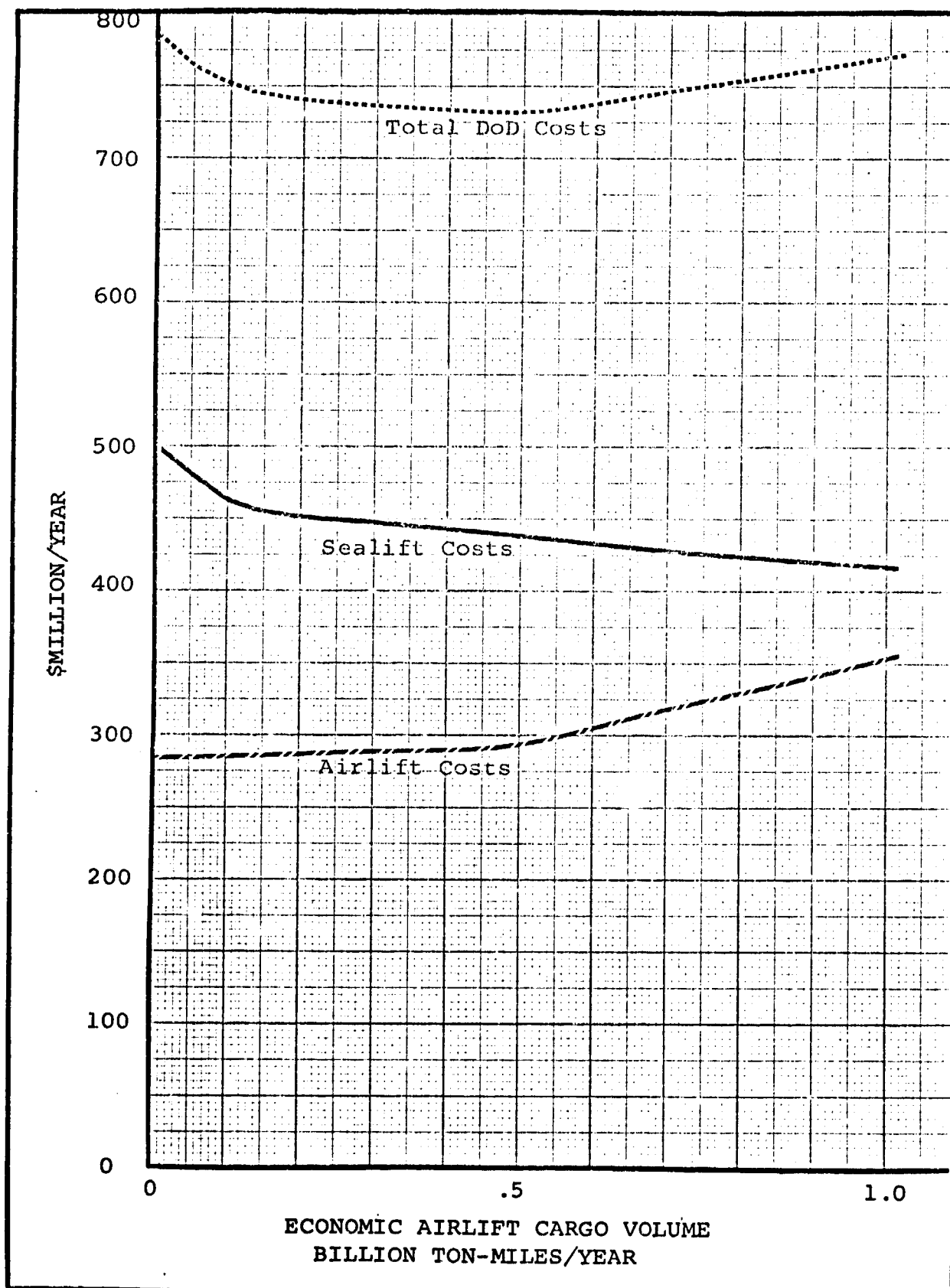
cargo. These cost changes per unit of cargo change, or incremental cost,[1] are plotted on Figure 3 against the amount of economic airlift cargo and per cent use of the MAC fleet for all activities including priority cargo and special missions.[2] The curves show that the airlift incremental costs exceed the sealift incremental costs at and above the airlift volume where the two curves intersect. The intersection coincides with the point in Figure 2 identified as minimum cost.

To the left of the intersection, Figure 3, airlift incremental costs are less than sealift decremental costs. Hence, total costs decrease as airlift volume increases up to the intersection. Thus, the intersection defines the optimum airlift cargo volume, the value of a unit of airlift capacity (i.e., the incremental or marginal cost), and the savings to the DoD (the area between the two curves to the left of the intersection).

E.   SUMMARY

Total potential savings (compared with no economic airlift cargo) are $61 million per year beginning July 1971, making due allowances for military requirements. The range of potential savings for FY 1971 and later years is given in Figure 4. Corresponding to the input data uncertainty, the range of estimated savings from July 1971 on, is from $17 million per year to well over $100 million per year. Consequently, even the lowest estimated annual savings are substantial and well worth the cost of refining existing procedures.

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[1]Often called by other terms such as slope or marginal cost.

[2]The point labeled "inventory saving limit" corresponds to the point beyond which items would exceed assumed wartime capacity. For such items, inventory cannot be reduced according to the assumption used in LMI calculations.

FIGURE 3

INCREMENTAL
SUPPLY-DEMAND
CURVE FOR AIRLIFT
AVG - JUNE 1971
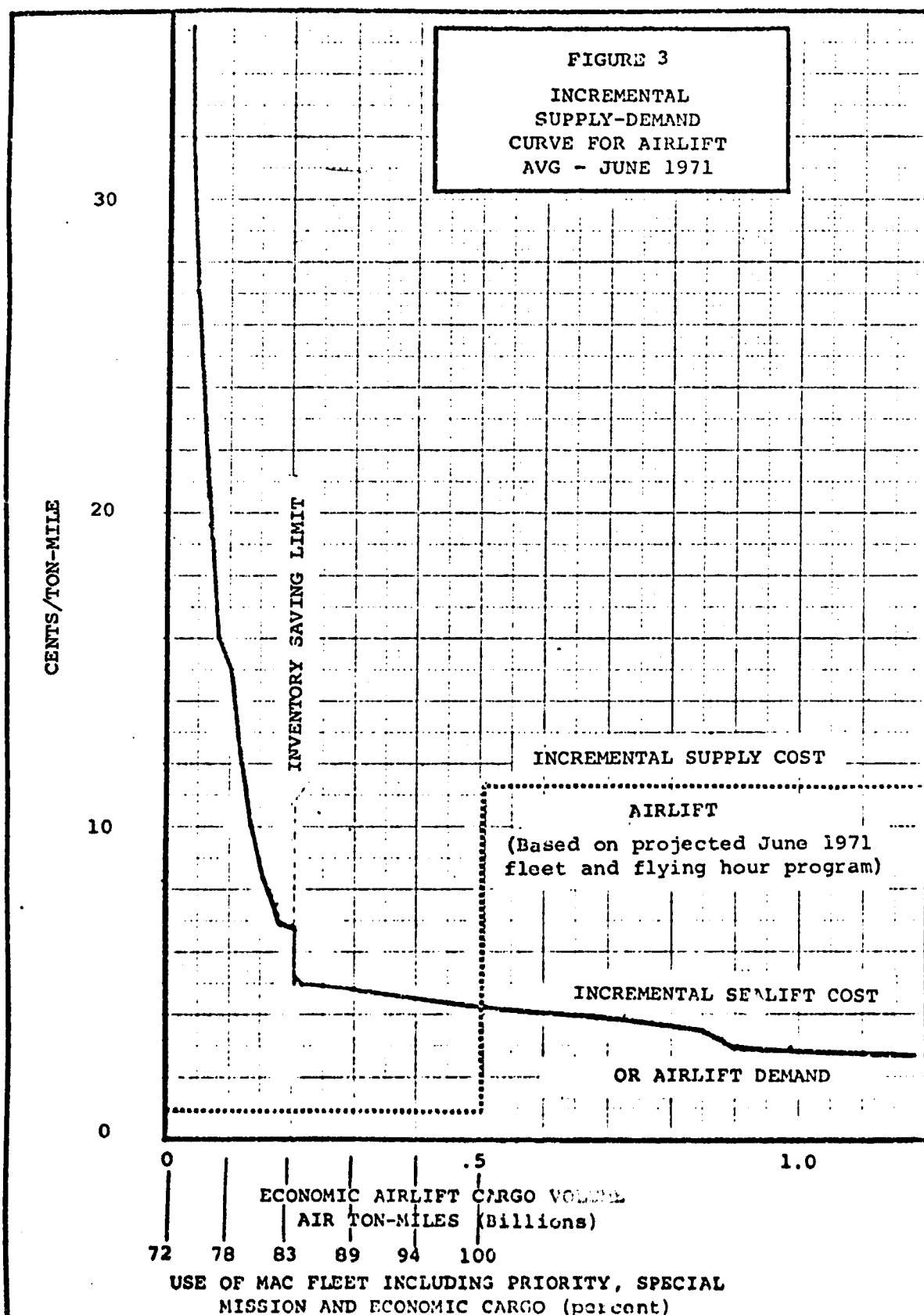
FIGURE 4

ESTIMATED
TOTAL POTENTIAL SAVING
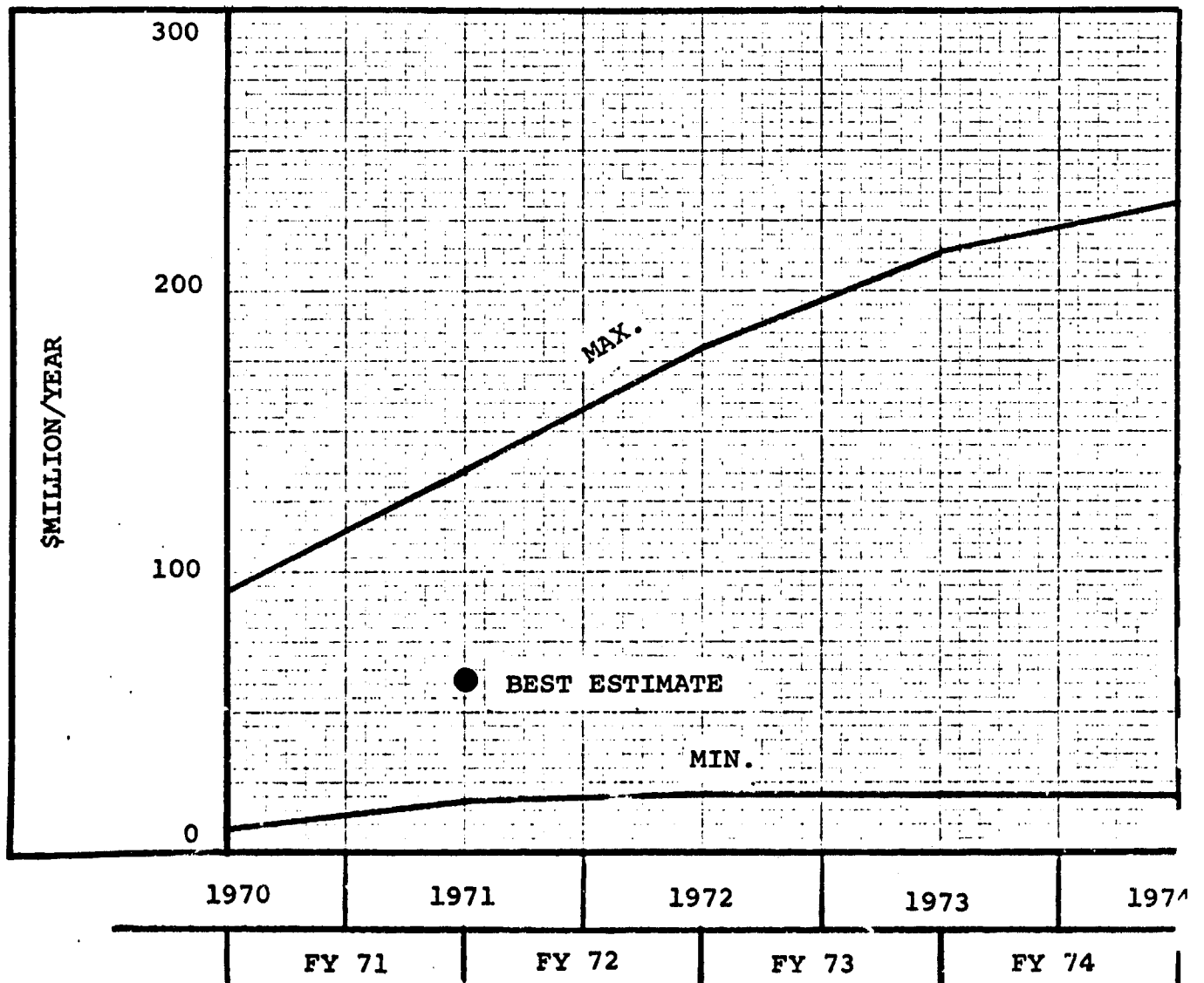
TABLE 1

<u>ESTIMATED</u>
<u>DoD DISTRIBUTION COSTS FOR SELECTED AMOUNTS</u>
<u>OF AIRLIFT CARGO</u>

June 1971

Outbound Traffic in Addition to Priority Traffic		Estimated Annual Cost			Remarks
Airlift Short Ton-Miles (Million)	Sealift Meas. Ton-Miles (Million)	Airlift ($Mill)	Sealift ($Mill)	Total DoD ($Mill)	
0	34,190	285	507	792	Within 4½ hour Flying Program
200	33,480	288	455	743	Within 4½ hour Flying Program
500	31,970	292	439	731	SAVING = $61 Million 4½ FLYING HOUR 224 C-141, 27 C-5
2,000	26,990	475	386	861	
18,400	0	4,180	0	4,180	Incremental airlift intercontinental cost = 22¢/STM

Source: Calculations described in Appendices 2 and 3 using best
estimate of June 1971 inputs.

III. THE CRITERION

The air eligibility calculations summarized in Table 1 (page 25), were complex because of the number of calculations, the variety of data, and the number of functional offices supplying the input data. It would be impossible for such analysis to be applied to each overseas requisition. The overseas requisition for an item initiates the process which leads to overseas air-lift consideration. Therefore, a type of criterion should be selected which is related to the catalog properties of the item and hence easily available when the requisition is processed.

An extensive list of item properties was tested in the 1969 RAC study,[1] The best property was price density, or dollars per pound ($/lb.). This is logical because the major savings result from inventory reductions which are proportional to item price, and the major cargo charges of airlift are proportional to weight.

Air eligibility classification by commodity groups or by supply classes is not as reliable as dollars per pound because of two factors: (1) available data on the class or group as a whole may be inaccurate, and (2) variance within the class r group is large so that many items would be misclassified. LMI believes price density is the most feasible criterion and is recommending that it be adopted.

This section describes how the criterion is calculated. The resulting savings are also discussed. Input data uncertainty results in a large range of values which can be calculated for the criterion. Therefore, the more important data uncertainties

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[1] Op. cit., Volume 1, p. 74.

and the general need for continual review and correction of
data are covered in concluding this section.

A.   THE PRICE/DENSITY CRITERION

Figure 5 is a plot of estimated annual savings vs. volume
of airlift cargo for June 1971. At 40% of the flying hour
capacity, 80% ($48 million) of the total potential savings
($61 million) are obtained. Moreover, 73% ($44 million) of
the total potential savings are caused by inventory reductions.
These percentages suggest: (a) an exact criterion is not es-
sential to obtain most of the savings because they can be ob-
tained without full use of the MAC airfleet flying hour capa-
city, and (b) a criterion related to item price should be effi-
cient because so much of the savings are related to inventory
reduction.

The most promising criterion is price density, i.e., dollars
per pound ($/lb.). The method which LMI used to determine the
value of this criterion, is to rank the items predicted to be
shipped overseas by the criterion (highest price per pound first).
Then for each item in order, the incremental DoD distribution
costs are calculated both for sealifting the item, including
the cost of extra inventory, and for airlifting the item. The
difference between the sealift and airlift incremental costs
is cumulated. The cumulative difference for a selected item
represents the potential savings if all items are airlifted the
price density of which equals or exceeds that of the selected item.

A plot of this relation--savings vs. price density--is
given on Figure 6 for June 1971. At the flying hour limit

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[1]The computer program is available at LMI.

FIGURE 5

ESTIMATED SAVING vs. TON-MILES
JUNE 1971

FIGURE 6 $/lb. vs. ANNUAL SAVING

JUNE 1971
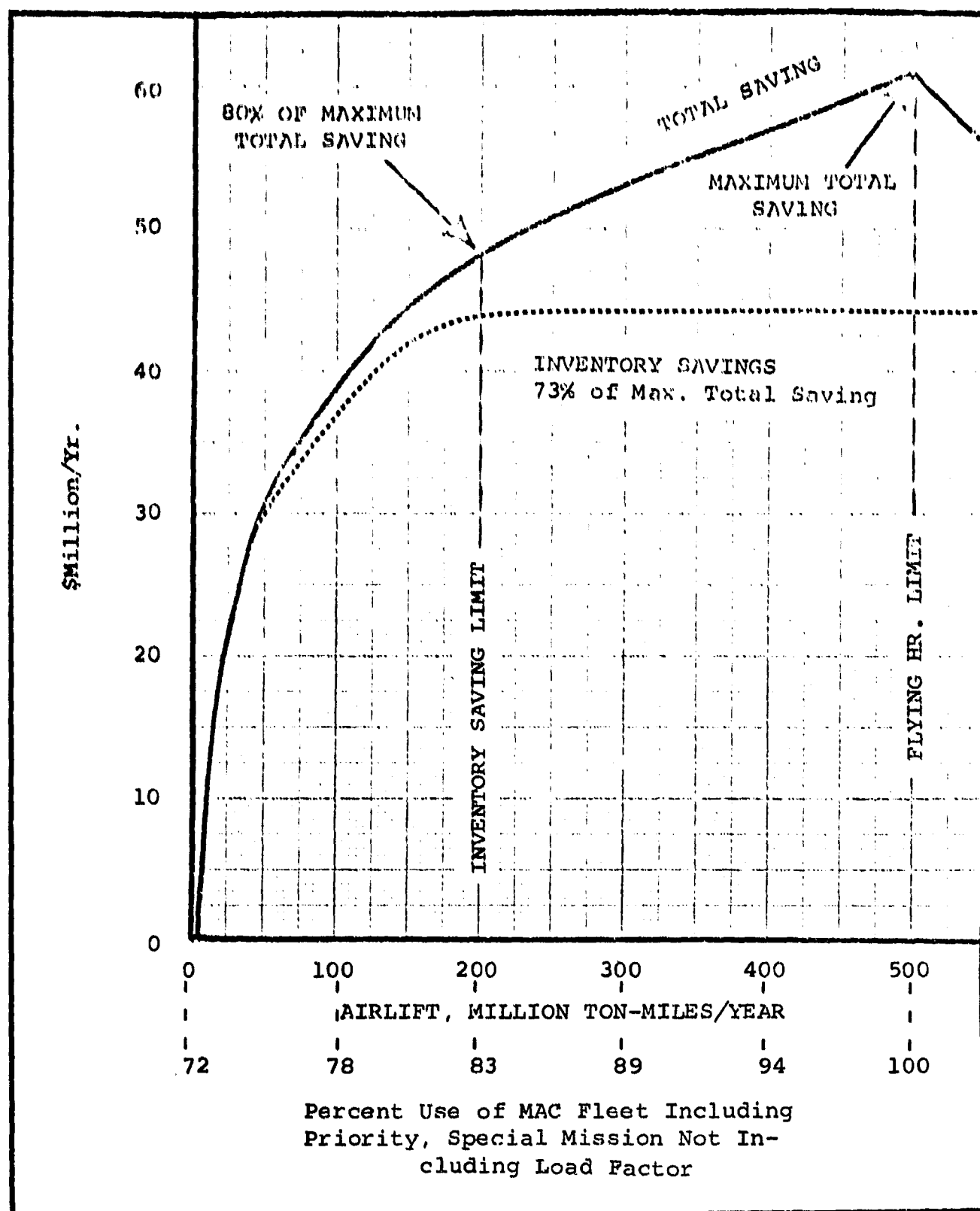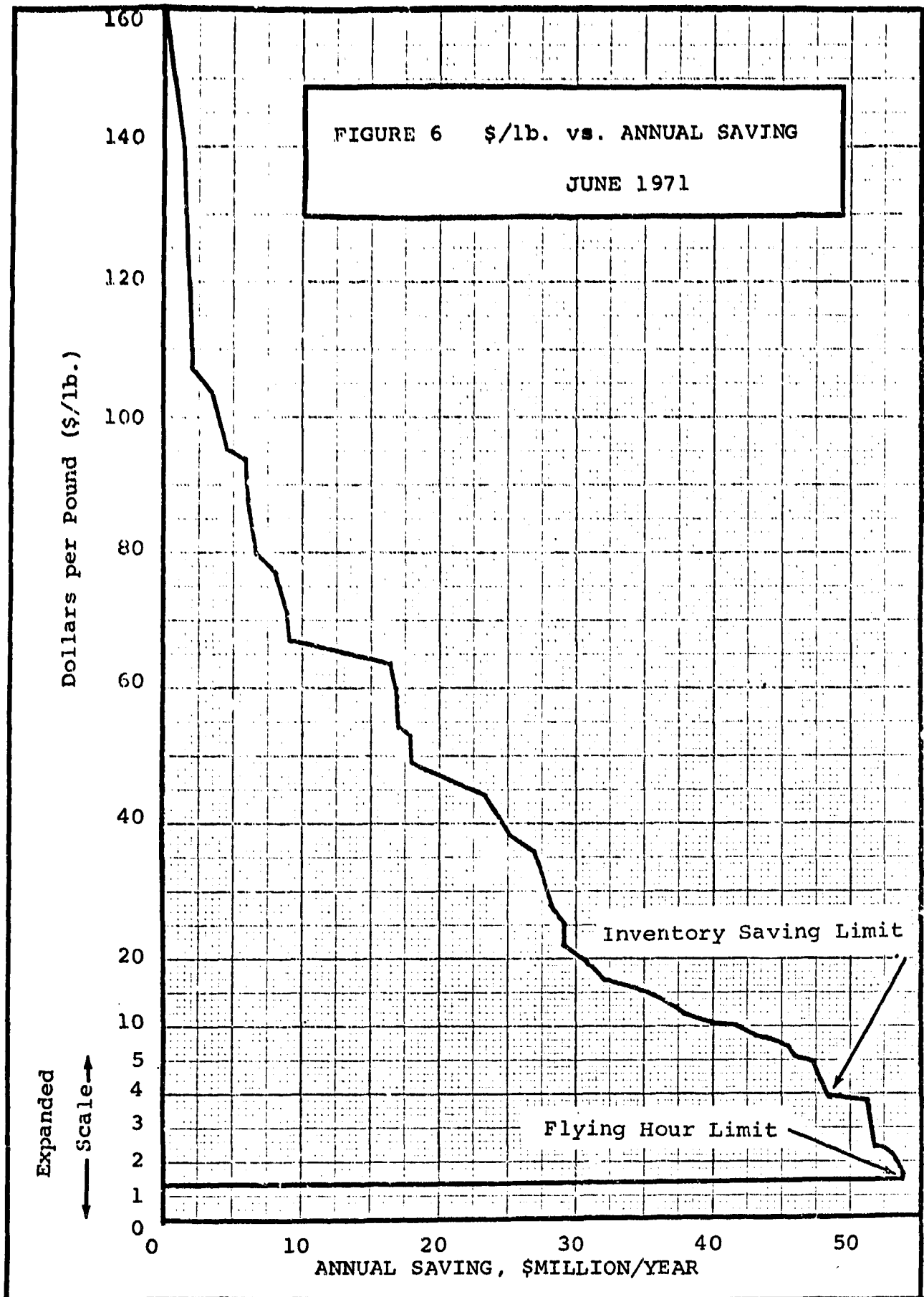
maximum savings are $53 million per year and the criterion is
$1.47/lb. The savings obtainable using price density as the
air eligibility criterion are 87% of the maximum obtainable
savings ($61 million).[1] Hence, price density is a very ef-
ficient criterion and suitable to initiate implementation.

At the assumed limit of inventory savings $48 million per
year is saved and the price density criterion is $3.87/lb.
Thus relatively little additional savings ($5 million) cumulate
between $3.87/lb. and $1.47/lb. Most of the additional savings
are from reductions in port handling and packing costs. More-
over, the $1.47 figure is considerably less than the value at
the inventory saving limit point expected for June 1974, name-
ly, $3.86.[2] Consequently, if $1.47/lb. were to be used and the
non-inventory savings proved illusory, or inventory savings
were not worth the increased risk of wartime shortage, costly
reclassification of items back to sealift would be necessary.

Estimated maximum annual savings vs. economic airlift
cargo ton-miles for June 1971 are shown on Figure 7, together
with savings obtained using price density as a criterion. It
can be seen that 80% of the total savings would be obtained by
use of the $3.87/lb. figure (the inventory saving limit point).
Moreover, all of the inventory savings within the conservative-
ly selected inventory saving limit are obtainable. If the
remaining cost reductions, mainly port handling and packaging
costs, are not realistic,[3] it may be that 100% of the real
savings can be obtained by use of the $/lb. criterion.

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[1] As explained on page 25, the maximum savings are obtained
by classifying those items air eligible which are able to pay
the highest air fare and still break even. See also discussion
on pp. 2-10 to 2-11.

[2] Appendix 3, Table 3-20.

[3] See pages 44 to 45 for discussion of packing costs.

FIGURE 7

ESTIMATED SAVING vs. TON-MILES
JUNE 1971
COMPARISON USING TWO CRITERIA:
DOLLARS/LB. AND CENTS/TON MILE
(See Text)
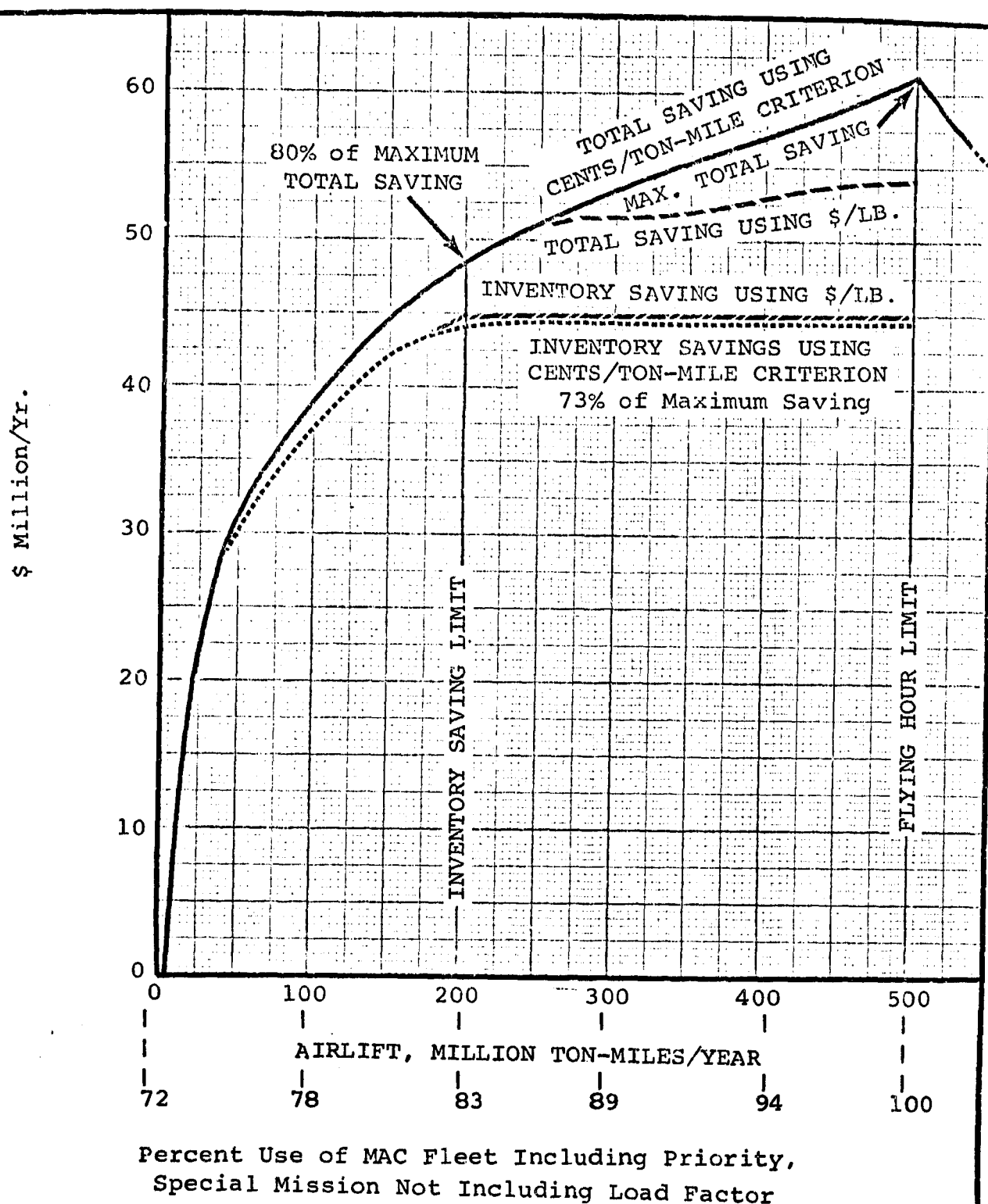
B.   NATURE OF EXPECTED SAVINGS

Use of economic airlift can result in considerable savings, as shown in Figure 4 (page 30). Not all savings will be in the form of budget reductions and some savings are not obtainable at all. This subsection discusses the savings obtainable and those not obtainable, classified as to reason.

The most obvious problem in estimating potential saving is the uncertainty. Figure 4 shows estimates between $17 million and $130 million in Calendar Year 1971 and $19 million and $231 million in Calendar Year 1974. The range of uncertainty stems from uncertainty in available data (discussed in some detail in Subsection C). This data imprecision also can cause costly errors. For example, if the air eligibility criterion, $/lb., is too high, economic opportunities will be lost, and, if too low, inventory will be reduced for items which might not be air-lifted routinely in war, thus compromising readiness. This latter error is not so serious initially because airlift capacity is on the rise and the criterion value will decrease.

It is certain that the stock levels of many items in an overseas inventory management system will not respond to a re-duced O&ST. If we assume that the overseas reorder point of 50% of the items will be responsive to actual O&ST, then $61 mil-lion out of a potential $94 million in savings can be obtained in FY 1972.

Some of the savings will be cost avoidances, such as improve-ments in capability at no extra cost. In this category are those air-eligible items for which inventory is already below sealift requirements. LMI was not able to develop a precise estimate of the number of items in this category but, if 50% of the items are in that position because of budget cuts or are being regular-ly airlifted already, then some $27 million of the savings will be cost avoidances.

If the reduction in unused capacity in wartime turns out
to be small (contrary to the discussion in Section II.C.), the
airlift criterion could be lowered and total DoD costs could
be reduced an additional $4 million. If precise criteria could
be used at no additional administrative expense, another
$7 million could be saved in 1972.

A summary of the savings and cost avoidances for the vari-
ous reasons discussed above is shown in Table 2.

TABLE 2

DISTRIBUTION OF POTENTIAL TOTAL SAVINGS

June 1971

	$ Million	Per Cent
Dollar Savings Obtainable	27	28
Cost Avoidances Obtainable	27	28
"Saving" Not Obtainable Because of War Considerations	4	4
Additional Potential Saving Obtainable if Perfect Criterion Could be Used in Lieu of $/lb.	7	7
Additional Potential Saving Obtainable if Inventory Fully Responsive	33	34
Total	98	100
Uncertainty in Estimate of Saving	±29	±30

In addition to the savings obtainable by overseas airlift, the air eligibility analysis provides an estimate of the value of saving one day's time in actual O&ST. Such an estimate may be used for evaluating time reductions elsewhere in the distribution system. For example, LMI estimates it will be worth about $13 in June 1971 to reduce the movement time for one short ton of overseas cargo by one day.[1] It is probably worth $13 to reduce movement time by one day for a short ton of cargo anywhere in the distribution system such as in CONUS movement or in any loading or staging area. This figure can be used to assist in the evaluation of many of the improvements to the distribution system now under consideration. These include (1) more LOGAIR or QUIKTRANS, (2) MAC airfleet local pickups, (3) more unitization, (4) less circuitous ocean vessel routing, and (5) expedited service.[2]

C. UNCERTAINTY

As mentioned earlier, there is a large uncertainty in the input data. The figures discussed in A., above, are the best estimates based on the assumptions that the most probable input is halfway between the upper and lower limit of each input.

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[1] From Table 3-20, the value of airlift at the inventory saving limit is 6.82 cents/ton-mile. The average overseas leg distance is 5,800 miles (Table 3-2 shows 8.17 billion ton-miles and 1.409 million tons; 8.17 billion ton-miles ÷ 1.409 million tons = 5,800 miles.) Therefore, it is worth $400 (5,800 x 6.82) to airlift a ton of cargo. Figure 3-8 shows airlift saved about 30 days. Consequently, the value of reducing movement time for one ton of cargo is about $13 (= 400 ÷ 30).

[2] Most of the O&ST is not used by the overseas vehicle. For example, UMMIPS indicates about 40% of the total O&ST allowed for high priority cargo is used by the intercontinental flight. Also, samples of MSC records showed the direct steaming time across the Pacific for a sample of ships was less than 34 days, which is 40% of the O&ST allowed for lowest priority traffic according to UMMIPS. Therefore, inventory savings potentials throughout the distribution system, aside from the question of intercontinental airlift, are substantial.

For the range of input data used, airlift volume, criterion and savings for June 1971 are as shown in Table 3.

TABLE 3

RANGE OF AIRLIFT VOLUME, CRITERION, AND SAVINGS

June 1971

	Outputs For Range of Input Data as Shown[a]		
	Maximum Airlift	Best Estimate	Minimum Airlift
Airlift Volume at Inventory Saving Limit, Million Ton-Miles	324	201	111
$/lb. @ Inventory Saving Limit	$3.87	$3.87	$4.86
Saving @ Inventory Saving Limit, $ Million/Year	$112	$48	$13

[a] For the outputs in the column headed "Maximum Airlift" each input datum was set at the extreme of its range which maximized economically eligible airlift. In the column headed "Minimum Airlift" input data were set at the extreme of their range which minimized economically eligible airlift. In the column headed "Best Estimate" each input datum was at its mid-range.

Source: Table 3-20 in Appendix 3.

Figure 4 (page 30) illustrates the uncertainty in savings estimates and indicates that uncertainty increases for the more distant projections. The increases in future uncertainty result from increasing uncertainty of future key variables such as

surface pipeline times, inventory relationships between overseas reorder points and actual order and shipping time, peacetime cargo volume, and improvements in the distribution system. Continued use of estimated and projected criteria with such uncertainty must be avoided by yearly updating.

It is essential to improve the estimates presented in this report as the economic airlift eligibility program is implemented, and appropriate and accurate data and experience become available. However, it is not worth postponing the savings obtainable with a conservative criterion for the sake of a more refined criterion, which we believe can only be developed from experience during implementation of an economic air eligibility criterion.

Section IV discusses general implementation procedures and responsibilities. The responsibilities for refining data are part of the general procedures. LMI recommendations for those responsible for each type of data are included in Appendix 3 (Table 3-17) where sources are tabulated for the data used in this study. The balance of this subsection outlines some of the more important defects in presently available input data.

The input data do not uniformly affect the output because of the sharp rise in the incremental airlift cost at the flying hour capacity limit. Some of the input data affect the criterion only and some affect only the value of the resulting potential savings.[1] For example, a change in sealift packing or seaport handling costs would only affect the value of the savings. There would be no change in the criterion of $/lb. On the other hand, the volume of cargo, the residual capacity of the flying hour program, and the proportion of items responsive to O&ST reductions, affect both the criterion and the cargo diverted, thus

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[1] Appendix 3, Table 3-22, lists the input variables and the output variables affected.

affecting traffic management, scheduling, and other planning functions.

1. Packing Costs

Comparison of the data used in previous models has proven instructive. In the IDA/WSEG Study the difference between packing for sea and packing for air was considered negligible, primarily because of the expected future large-scale use of containers.[1] By contrast, RAC found that packing cost differences are significant.[2]

Other factors have been identified that bear on the issue, namely: (1) packing often is determined without knowing the transportation mode; and (2) packing often is dictated by overseas storage requirements. Verification of cost differences is most difficult because packing costs are not separate budget line items.

Because of uncertainty in packing costs, calculations were made with a large range in the assumed packing cost differences between airlift and sealift. The differences ranged from about $10/short ton less for sealift to $40/short ton less for airlift.[3] Since inventory savings exceed all other savings, most of the potential packing cost saving, if any, cannot be recovered unless considerably more than 500 million ton-miles/year are airlifted. Capacity limitations, therefore, initially rule out most of the packing savings.

For the future it appears that the packing cost differential may increase as economic air eligibility classification

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[1] Op. cit., Volume 1, pp. 71-72.

[2] Op. cit., Volume 1, p. 52, ff.

[3] The packing cost differences are hard to characterize accurately because the sealift costs are proportional to volume, while airlift costs are proportional to weight.

influences packing practice; but the differences ultimately may decline if containers are more widely used. In any case, because of the large cost uncertainty and the possible impact on packing of the implementation of the air eligibility criterion, estimates should be made of a sample of data on differential packing costs when the economic air eligibility criterion is implemented. If the differences are significant, more precise criteria or fuller use of the flying hour program capacity may prove worth while.

2.   Cargo Volume

Estimates of both peacetime and wartime cargo demand volume are required for realistic determination of air eligibility. Wartime volume is necessary to determine what items should be airlifted routinely in wartime, because the mobilization material requirements for those items can be reduced. The expected wartime cargo volume depends on the scenarios and mobilization requirements envisioned by the planners.

Peacetime cargo volume and its characteristics also are essential to determine peacetime cargo requirements and savings. However, the most recent peacetime cargo data are for FY 1965. The technology and strategy changes since then make a six-year old figure highly suspect. The available projections differ by more than 2:1, and emphasize this uncertainty.[1] Also, important characteristics of the items have changed in six years. For example, if the proportion of high-price density items has increased there would be an increase in the $/lb. criterion for air eligibility. For convenience, LMI used the 1965 RAC outbound data base to determine the distribution of item characteristics. However, the average density of all overseas shipments

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[1] See Table 3-1 and Section C.1.a in Appendix 3.

(including airlift and sealift) according to that data base is
29 lbs./cu.ft.[1], while the average density of FY 1970 cargo is
about 20 lbs./cu.ft. We were not able to determine why the
disparity exists but it emphasizes the need for better demand
data. Sampling procedures should be established to obtain a
reliable estimate of the characteristics of the O/S cargo de-
mand and of total volume. Also, estimates of retrograde cargo
need to be made, as discussed in Section IV.

3.   Flying Hour Program Residual Capacity

A number of factors influence deductions from airlift
capacity for training, circuitous routing, special missions,
and the amount of priority cargo. Data on those factors avail-
able to LMI are based primarily on recent C-141 experience or
peacetime records from six years ago. Therefore, errors are
bound to exist in our projections for the transition period follow-
ing Vietnam and the peace period afterward, especially because of
the entry of the C-5, which will dominate MAC's capacity.

4.   Items Able to Respond to Order and Shipping Time Changes

The current state of overseas inventory management
appears unsuited to implementation of air eligibility for many
potential air eligible items.[2] Since the largest potential
saving from airlift results from inventory reduction, the key to
implementation is inventory management. For example, if overseas
stockage and order points of a potentially eligible item are

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[1] Table 3-2, Appendix 3.

[2] Cf. CINCLANTFLTINST 4440.4A (721), 22 January 1970:
"Atlantic Overseas Bases Stocking Policies," Department of the
Navy, U. S. Atlantic Fleet, par. 6, which specifies fixed O&ST;
R. M. Clarke, et al., Comparison of U. S. Army and USAF Secondary
Items and Repair Parts Supply Support System, Research Analysis
Corporation, R-95, June 1970, p. 19, which summarizes the general
state of inventory management; LMI, Inventory Control of Army Non-
Combat, Essential Items, Task 69-8, April 1970; and LMI Inventory
Ordering Rules for Secondary Naval Air Stations, Task 70-14, May
1971.

not dependent on the actual order and shipping time, the opportunity to reduce overseas and pipeline stocks is lost.[1]

Inventory management constantly is being improved.[2] The changes inherent in the improvement efforts make precise data on the current status of any large group of items difficult to obtain. Such elusive data include information on (1) whether overseas reorder points are responsive to actual order and shipping time, and (2) the status of mobilization reserve stocks.

Inventory savings used in LMI's calculations are based on assumed aggregated factors. This aspect is sensitive because the inventory savings are the major airlift benefits and the exact savings are intimately dependent on inventory management. For example, before savings can be accurately determined, the inventory calculations must consider: (1) the mobilization material requirement, (2) methods of inventory management, such as multi-echelon depot arrangements as affected by airlift, (3) the precise change in reorder level resulting from the actual reduction in average O&ST, and (4) the safety stock revisions. Inventory modeling, which can permit precise calculations of savings due to airlift, is complicated in its own right and also is necessary for sound inventory management.[3]

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[1] The order and shipping time is the time elapsing between initiation of a requisition and the receipt of the goods by the requisition. Cf. JCS, Pub. 1 op. cit., p. 105.

[2] A relatively recent improvement is exemplified by DoD Instruction 4140.39, "Procurement Cycles and Safety Levels of Supply for Secondary Items," July 1970.

[3] See Section C.1.b., pages 28 to 29, in Appendix 3.

IV. IMPLEMENTATION PLAN

A. GENERAL

A plan for implementing the proposed criterion is presented in order to:

1. Show that the criterion can be reduced to practice. It is not sufficient that the criterion be a simple arithmetic formula. The criterion is practical only if it can be easily adapted to existing DoD procedures.

2. Provide the instructions for reducing the criterion to practice, and

3. Provide the base for subsequent improvements in both the procedures and the data for the calculations.

The plan includes the information flow and sequence of actions that are required, the policy statements and instructions, and the responsibilities. We have tried to devise a system that is:

1. easy to administer, providing feedback that can be used for determining new criteria values and for assessing compliance,

2. compatible with the management procedures for individual items,

3. compatible with the operation needs of the traffic and supply systems,

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4.   responsive to changes, and

5.   effective, in that it captures a large percentage of the potential savings.

B.   THE PLAN

The implementation plan is presented in two levels of detail: (1) a summary description for policy makers and managers, and (2) a detailed description for those who must implement the plan.   The information flow is presented in Figure 8, page 69.

The process of developing and using an economic criterion is cyclic: the OSD develops and issues the criterion value for the military services to use; the services in turn provide OSD with data required to develop the criterion value for the next cycle. Changes in policy, technology, and cost factors will influence calculation of the criterion value for the ensuing cycle. We suggest one year as an appropriate time period for one cycle to fit in with the budget cycle.

1.   Summary Description (Refer to Figure 8, page 69).

Step 1.   LMI is recommending in this report the criterion value (in $/lb.) for use during the first cycle and the airlift cargo (in ton-miles) expected to be generated by the criterion.

Step 2.   The OSD will document (1) that an economic air eligibility criterion will be used by the military services, and (2) the specific dollars per pound criterion to be used during the first year.   (In subsequent cycles, the criterion will be redetermined based upon air eligibility experience).

Step 3. The Services will determine those items in their
supply system(s) for which the ratio of catalog price to weight,
equals or exceeds the criterion specified by the OSD. If such
an item is not to be bought during the period being planned
for--more specifically, the ICP reorder point assuming sealift
is not expected to be reached--the item will not be considered
eligible for airlift on economic grounds. If the item is to
be or should be procured during the period being planned for,
and its O/S ROP is responsive to actual O&ST,[1] savings from re-
duced inventory can be realized by airlifting such items. Such
items will be called air mandatory. However, in order to
routinely airlift them, several steps need to be taken:

(a) The O&ST that are used for the overseas depots
must be adjusted to reflect airlift times.

(b) The overseas depot reorder points must be ad-
justed to account for the shorter airlift O&ST.

(c) The ICP must recalculate its own procurement
schedule to reflect the above adjustments.

(d) Each appropriate record of air mandatory items
must be coded so that all persons who work with the records will
know which items must be shipped by air. Finally, requisitions
for such items will specify airlift. Depots filling the requi-
sitions will prepare the item for, and move it into, the air-
lift system.

Step 4. The next consideration in the implementation
plan is the review or challenge that is made of shipments as

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[1]This includes consideration of depot procedures as well
as mobilization reserve and resupply requirements.

they move into the transportation system. Items that have been designated air mandatory will be challenged only from the standpoint of supply, that is, only on such data as quantity and requisition date. The transportation challenges, such as weight, size, and density, will have been applied by the item manager when he determined that an item was air mandatory.

Step 5. The Military Airlift Command moves the goods through the airlift system. Data on the actual ton-miles of cargo used in the movement of air mandatory items are fed back to OSD to assist in evaluation and adjustment of the criterion during the subsequent cycle.

Step 6. Near the end of the cycle (end of the fiscal year) each of the military departments and MAC, MSC, and the Military Traffic Management and Terminal Service (MTMTS) will forward the data required by OSD to calculate the criterion for use during the next cycle.

Most of the required data are available, but some of the critical elements like cargo and inventory factors are not now available in appropriate form. Eventually, it may prove satisfactory to adjust the criterion merely by comparing expected with actual cargo, although the comparison probably cannot be made in transition periods when trends become obscured. In the meantime, cargo data, at least on a sample basis, probably are also needed for other traffic and budgeting purposes.

Inventory calculations are complex. However, accurate inventory factors are essential to efficient, responsive inventory management. Hence, it is anticipated that such data as are necessary should be available as inventory models are implemented.

Step 7. OSD calculates the economic air eligibility criterion value for the next cycle and the estimated airlift cargo ton-miles expected to be generated by that criterion. These figures may be adjusted based on a comparison of the actual cargo reported in Step 5 with the expected cargo.

2. Detailed Description

Step 1. The value of the criterion that LMI is providing to the OSD via this report, discussed in detail in Section III, will permit the first cycle of the economic air eligibility criterion system to get under way. Values for subsequent cycles will be developed from the data collected during each preceding cycle. Recalculation of the criterion from more precise data is essential to take full advantage of the cargo capacity generated by the flying hour program.

Step 2. To begin the first cycle, the OSD should issue one new instruction, make modifications to several directives, and revise the references of several more to include the basic directive setting forth the economic criterion. A discussion on the directives involved and, in some cases, draft texts are provided in Appendix 4. A new instruction or an attachment to a new instruction will announce the criterion (dollars per pound) that is to be used by all shippers during the next cycle.

Step 3. Upon receipt of the criterion, the military services will examine each item in their supply system at or above the criterion, to determine the items that should be declared air mandatory. There are four action levels within the Services as outlined in Table 4.

TABLE 4

IMPLEMENTATION PLAN
DoD COMPONENT ACTIONS

LEVEL	ACTION
Headquarters Staff	Modify Service Directives
	Prepare Specific Instructions
	Prepare Transfer of Funds
	Adjust Transportation Requirements and Budget
	Determine War Requirements
ICP	Determine Whether Item Is To Be Bought This Cycle
	Determine Whether Item Is Responsive To O&ST
	How Much Can Inventory Be Reduced and Still Meet War Requirements?
	Review Transportation Requirements (Challenges)
	Determine Overseas Depot O&ST and Inventory Cost Savings Factors
	Examine ICP Procurement Schedule
	"Flag" Stock Record & TCMD
Overseas Depot	Adjust O&ST
	Adjust ROP
	Ship Retrograde by Air as Appropriate
CONUS Stocking Depot	Adjust Packing and Procedures
	Ship Via Air

a.   Headquarters Staff

All directives and instructions that bear upon
inventory management, transportation mode selection, and traffic
management must be reviewed and modified as needed to insure
that all supply, transportation and financial personnel know
that the economic air eligibility criterion is to be used. Most
of the current instructions do not cover the use of a compre-
hensive criterion such as we are proposing. As a result, new
or revised instructions, covering both supply and transportation
aspects of air eligibility, will have to be prepared.

While there will be substantial savings (pri-
marily from reductions in inventories), there will be an increase
in airlift expenditures over what would have been spent in peace-
time. Funding must be adjusted to pay the increased costs of
air transportation and to make the savings available for other
purposes.[1]

Estimates of the peacetime cargo to be shipped
overseas will be required to develop the criterion value for the
next cycle. To preclude supply shortages during emergencies,
the mobilization reserve stocks and other wartime resupply factors
also need to be determined. That determination will permit the
identification of those items whose inventories cannot be reduced
safely regardless of the mode of transportation.

b.   Inventory Control Point (ICP)

When the criterion value (dollars per pound) is
received by item managers they will examine their items to

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[1]The average economic airlift item will be charged 13 cents/
ton-mile (Table 3-25, Appendix 3) and save by airlifting 24 cents/
ton-mile in June 1971 (24 cents/ton-mile is the ratio between
savings of $48 million and air traffic of 201 million-STM given
in the "Best Estimate" column of Table 3-20), or a net saving of
11 cents/ton-mile to the Service.

determine those that are potentially air eligible according to
the criterion, or those items with demand or supply changes
likely to result in reclassifying the transportation mode.[1] For
each item equal to or exceeding the criterion, it must be de-
termined whether the item is expected to be procured during the
present cycle. If not, it should not be considered economically
air eligible. If the item is to be procured, then the ICP must
determine: (1) whether the overseas reorder point is responsive
to actual order and shipping times (O&ST) resulting from different
modes of transportation, (2) whether depot inventories can be
reduced and still meet war requirements, and (3) whether the item
is physically compatible with airlift, e.g., it is not outsized
or damaged by, or dangerous to, airlift.[2] If the answer to these
three questions is yes--that is, the overseas depot reorder point
is responsive to actual O&ST, a reduction in the depot stocks
can be made, and the item can be airlifted--then the item is
declared "air mandatory."

If there is sufficient stock for a sea pipeline
of an item already "air mandatory"--as might occur when such an
item is phased out--reclassification is essential, together with
corresponding adjustments, e.g., remove the "code" from the
records and change overseas ROP.

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[1]Items in short supply which involve special procurement
costs or for which immediate procurement is difficult, are also
examples of exceptions which may be air eligible.

[2]To determine whether air eligible items are physically com-
patible with airlift, the item manager, with assistance from trans-
portation specialists, will use the MILSTAMP challenges regarding
weight, size, etc., which are applied by the Shipping Service
Clearance Offices (SSCOs) and the Military Airlift Clearance
Authority (MACA).

Detailed inventory calculations will have to be performed to update inventory cost saving factors to be furnished annually to OSD for its redetermination of the air eligibility criterion. The calculations should consider various options such as multi-echelon vs. single-echelon depot systems, and overseas vs. CONUS repair to determine what savings could occur by the use of airlift. Estimated savings should be based on: (1) actual reductions in O&ST because of airlift, (2) the resulting inventory reductions and other one-time cost savings, and (3) the reduction in annual cost of holding the inventory.

Reductions in O&ST also affect procurement schedules. Shortening the overseas depot O&ST automatically reduces the depot reorder level. That reduction causes a delay in placing a requisition against the ICP, and a delay in the date when on-hand stocks will need replenishment. The delay in procurement results in actual one-time savings.

The final action taken by the item manager is to code appropriate stock records of those items declared "air mandatory" to inform all who are concerned with requisitioning, issuing, and distributing the items that they are to be shipped via airlift.

c. Overseas Depot

Upon being informed that an item has been declared "air mandatory," the overseas depot personnel adjust the O&ST to reflect predicted airlift transportation time reductions. Also, all stock levels and the reorder levels that are based on O&ST will be recalculated. The result should be a shorter O&ST, lower ROP, and a delay, equal to the difference between the old and new O&ST, in submitting the next requisition.

d. CONUS Depot

Shipping documents (TCMD) will specify the transportation mode and routing and require the CONUS depot supplying the item to pack it for airlift. The code placed on the stock records will be transferred to the TCMD.

Step 4. The supply and transportation review is performed by the Shipping Service Clearance Offices and the Military Airlift Clearance Authority. The documentation (advance TCMD) on airlift shipments is reviewed, primarily to determine if quantities, Required Delivery Date (RDD), destination, physical characteristics, etc., are appropriate. Other transportation challenges for air mandatory items will have been accomplished by the item manager at the ICP and should not be repeated by the SSCO or MACA. The primary concern of those organizations should be the appropriateness of the requisitioned quantity, and the destination specified.

In addition, clearance organizations may review the shipment to determine if the shipment should be expedited or if cheaper transportation than that indicated can be used and still meet the RDD. However, an "air mandatory" shipment should not be diverted from the airlift system simply to "save money" because inventories will have been adjusted to a high-speed transportation O&ST, upon which RDDs are based. Failure to meet the RDD will disrupt the distribution system.

Step 5. The airlift operation is the same for both "air mandatory" cargo and priority cargo, except that "priority" cargo takes precedence. The only additional requirement is in the area of data collection and analysis. MAC must tabulate the

tons and ton-miles of "air mandatory" cargo separately from priority cargo.[1] The tabulations will be used by OSD in evaluating economic airlift and in developing the criterion for the next cycle.

Step 6. Prior to the end of a cycle the OSD will receive from the military services, MAC, MSC, and MTMTS the data required to compute the new criterion and the estimate of economic airlift tonnage for the next cycle. (Required data are defined in Section II of this report and tabulated in Appendix 3, Table 3-17.) Many of these data are aggregated or general factors, and can be developed from data already being generated routinely by the airlift system.

Step 7. Upon receipt of required data, OSD develops the criterion for the next cycle. It is anticipated that the computer program developed by LMI, and discussed in Appendices 2 and 3 will be used initially. That program will also provide the expected airlift ton-miles to be flown during the cycle and other factors that can assist in managing the airlift system. In addition, the value of reducing O&ST by means other than overseas airlift will be calculated to aid in evaluation of other potential improvements such as reducing the waiting time at a staging area or adding a shift to depot operations.

Comparison of previous cargo projections with the actual cargo figures obtained in Step 5 should assist refinements of the dollars per pound criterion. The next action cycle is initiated by publication of the value in a version of the new DoD Instruction.

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[1]The code in the records will indicate which items are air mandatory. Separate tabulations should also be made of cargo which is both "air mandatory" and "priority."

3. Alternative Criterion

LMI believes that dollars per pound is the best criterion of airlift eligibility for use at this time. The Army is implementing an alternative air eligibility procedure based on the second RAC study.[1] The Army procedure utilizes tariff charges and requires a cost calculation for each item to determine the least cost transportation mode. The procedure closely follows that used in developing Figure 3 (page 29). In theory it is more efficient than the $/lb. criterion (that is, it should result in recovery of a greater percentage of the theoretical savings); however, we believe that the procedure is more complicated than the present inaccurate and aggregated data base will support. Also, we believe that the use of tariff charges as the airlift cost in determining air eligibility is inappropriate, for the reasons discussed on pages 21 and 22. Moreover, detailed supply considerations essential to item management (step 3, page 56), may be overlooked.

If the Army desires to continue implementation we suggest that the procedure be modified to incorporate the individual item supply considerations of step 3, and the airlift cost used in the formulas should be the value of a unit of airlift capacity as defined at the inventory saving limit point of Figure 3 (page 29). For June 1971, the figure would be 6.8 cents per short ton-mile.

C. DoD DIRECTIVES REQUIRED

Implementation of the economic air eligibility criterion in the DoD will require the modification of some DoD directives, and the issuance of a new instruction. In addition, several

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[1]Cf. Ray M. Clarke, et al., op. cit.

directives, mainly in the supply area, should include references
to DoD Directive 4500.9, "Transportation and Traffic Management."

DoD Directive 4500.9 is the major policy document that
addresses the use of economic criteria for airlift. That direc-
tive already is oriented to the cost/effective use of transporta-
tion and needs only minor modification. We suggest that the
principles and procedures for using the criterion be appended as
an enclosure to DoD Directive 4500.9. The enclosure will include
the basic concept and objectives of the economic air eligibility
criterion, the assignment of responsibilities for putting the
criterion into practice, and the procedures for calculating a new
criterion. Drafts of both text changes to 4500.9 and the en-
closure are presented in Appendix 4.

The other document that needs modification is DoD Instruction
4410.6, "Uniform Materiel Movement and Issue Priority System
(UMMIPS)." UMMIPS develops a total priority scheme, based on
urgency of need, for all materiel movement and issue. In addition,
standard times for each issue and movement function are given for
each priority. Routine resupply is included in the lowest
"Urgency of Need Designator," for which standard time varies
from a low of 69 days to a high of 84 days, depending on the lo-
cation of the overseas destination. These are the longest time
standards in UMMIPS.

The time standard is used to compute the Standard Delivery
Date (SDD) for each requisition. Currently, if the delivery
date required by the requisitioner is earlier than the SDD, it
may appear on the requisition only for urgency of need reasons.
Therefore, to implement the economic air eligibility criterion,
UMMIPS must be revised to permit a requisition to show a Required
Delivery Date (RDD) for "air mandatory" items. To accomplish

this, without a disruption of the priority system, LMI proposes that paragraph VI.B.3, Enclosure 1, DoDI 4410.6, be modified to include a condition permitting, for air mandatory items, an RDD earlier than the SDD.

The shipping activities and transportation control agencies could modify the mode of transportation only if such modification would not jeopardize meeting the RDD or if substantial delays arose because the airlift system was continually saturated with cargo. Such saturation could become continual or unmanageable in peacetime, only if there was excess error in such input data as peacetime cargo volume or inventory responsiveness. If such errors are discovered, the criterion should be redetermined immediately.

The proposed changes (detailed in Appendix 4) will permit economic "air mandatory" shipments and still preserve the basic priority system.

The implementation plan calls for the OSD to set a new criterion value each year. A suggested draft of an instruction for publishing the criterion is included in Appendix 4.

DoD Directive 4500.9, "Transportation and Traffic Management," should be referenced in a number of DoD directives and instructions which are primarily supply oriented. Most of those documents already consider the basic principles of cost effectiveness and do not need modification of content. However, reference to 4500.9 will promote the uniform economic use of airlift within the overall distribution system. This category of directives includes:

1. DoD Instruction 3232.4, "Policy and Principles Governing Provisioning of End Items of Materiel." This document requires some modification of content.[1]

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[1] Provisioning is discussed in Subsection D.4 (pp. 67-68).

2. DoD Directive 4140.1, "Inventory Management Policies,"

3. DoD Instruction 4140.4, "Management of Materiel Pipeline, Including Levels of Supply," and

4. DoD Instruction 4140.7, "Control, Supply and Positioning of Materiel."

D. CRITERION APPLICATION IN SPECIAL CASES

The criterion and implementation plan presented apply to most supply items most of the time. Several special cases where modifications are necessary or where the criterion does not apply are discussed in the following paragraphs. These include: (1) retrograde, (2) shelf life and perishables, (3) morale items and passengers, and (4) provisioning.

1. Retrograde

The analytic procedure used for outbound cargo movement also applies to retrograde. However, the peacetime retrograde cargo volume is less than outbound cargo. Hence, in most peace-time cases, return airlift and sealift vehicles will be less loaded than outbound vehicles. Since the vehicle must return to CONUS, the incremental cost for all relevant capacity levels is nominal. Accordingly, any item which is "air mandatory" outbound would also be air mandatory as retrograde. In addition, many other retrograde items may also qualify for airlift.

If we assume, for example, that retrograde cargo has the same cargo characteristics but comprises only 21% of the outbound volume,[1] which latter we assumed to be 18.4 billion ton-miles, then the retrograde criterion in July 1971 is $0.75 per

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[1] For FY 1965 MSC dry cargo traffic figures show 1.71 million tons inbound and 8.06 million tons outbound.

pound at the inventory savings limit point. In other words, most retrograde items will be air eligible. The retrograde savings are about $9 million/year. Because the data on which this estimate is based are provisional (available retrograde data are very incomplete), it seems appropriate, at this time, to allow the individual military departments whatever option they desire regarding separate retrograde mode classification for items below the outbound criterion. Further investigation should be made to determine the actual amount and characteristics of retrograde traffic, the time and dollar savings that can be obtained, and the need for a special criterion to determine the mode of transportation.

2.   Shelf Life and Perishable Items

Shelf life and perishable items involve a higher rate of loss of inventory value than that used in developing the $3.87 per pound criterion. Because inventory savings already dominate, a simple mathematical modification is sufficient to determine a criterion.

Shelf life items are classified on the basis of months of shelf life remaining.[1] For those items with two or less months of shelf life (condition code C), it is pointless to ship by sea as the typical O&ST for this mode is 70 days.[2]

For items with three or more months of shelf life remaining, we may assume that 100% of the value of the item is lost at the end of the shelf life. Under this assumption the annual inventory factor would be tabulated as in Table 5, in lieu of the estimate of 35% we have used for other items.[3]

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[1] DoD Instruction 4140.27,"Identification, Control, and Utilization of Shelf Life Items," 12 September 1968.

[2] UMMIPS, 18 February 1971, Enclosure 2, p. 4.

[3] See page 27.

TABLE 5

<u>ANNUAL</u>
<u>INVENTORY LOSS RATE AS A FUNCTION</u>
<u>OF REMAINING SHELF LIFE</u>

Shelf Life Remaining Months	Rate of Loss in Percent of Value of Item
3	400
4	300
5	240
6	200
7	172
8	150
9	133
10	120
11	109
12	100
18	67
24	50

The criterion recommended in Table 6 for shelf life items is based on June 1971 "best estimate" calculations for the optimum point and the inventory factors in Table 5. We assume war requirements are not relevant since long-term considerations are ruled out by the fact that the items have limited shelf life.

TABLE 6

AIR MANDATORY CRITERION AS A FUNCTION OF REMAINING SHELF LIFE[a]

Shelf Life Remaining Months	$/lb.
3	0.13
4	0.17
5	0.21
6	0.26
7	0.30
8	0.34
9	0.38
10	0.43
11	0.47
12	0.51
13 to 18	0.77
19 to 24	1.03

[a]Using $1.47 per pound from Table 3-20 (Appendix 3) as the criterion equivalent to an inventory factor of 34.7%/year, the shelf life criterion is calculated as the ratio: $/lb. = 1.47 x 34.7 ÷ loss rate from Table 5.

3. Passengers and Morale Items

The task order directed that passenger traffic and the morale impact of certain personnel-related items be considered in developing the cargo criteria. It is difficult to consider the morale impact in economic terms--if market prices are used to determine mode of shipment, most of the morale aspects are

neglected. As a result, decisions concerning shipment of morale
items remain outside the realm of economic criteria. The total
traffic involved is probably small enough to be readily absorbed.
However, airlift shipments should be sampled to verify whether
the proportion of morale items is small.

Passenger traffic economic considerations involve the
calculation of the total personnel costs (base salary, recruiting,
training, leave, etc.) for the difference in the sealift and air-
lift pipeline times. Since, as has been determined in the past,
the savings by using airlift are greater than the costs, then
airlift should be used. While straightforward, this approach
overlooks morale. Moreover, there appears to be no relation be-
tween passenger traffic and cargo air eligibility classification.
Therefore, further study of passenger traffic influence on cargo
criteria were considered to be beyond the scope of this study.

4. Provisioning

DoD Instruction 3232.4, "Policy and Principles Govern-
ing Provisioning of End Items of Material," includes policy for
those end items for which _extended_ provisioning is allowed.[1]
The price per pound of many such items will exceed the air eli-
gibility criterion. Therefore, the instruction also should refer
to economic airlift eligibility considerations so that initial
buys do not result in lifetime stocks exceeding what is necessary
for an airlift pipeline for economically air eligible items.

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[1] Cf. para. VI.B. Extended provisioning, as used in this re-
port, refers to procurement of spares, repair parts, etc. to sup-
port and maintain an end item wall beyond its initial period of
service.

To determine the mode of transportation and thereby
the level of pipeline inventory for extended provisioning de-
cisions in the next two years, the air eligibility criterion
in force at the time of the decision should be used. During
the first two years the criterion is conservative, minimizing
the risk of having to reclassify items. Reclassification of
extended provisioning items is especially costly because of
the likelihood that high production start-up costs are required.

After the first two years, experience with air eligi-
bility of extended provisioning items may indicate whether the
initial decision should be based on the current criterion or
some future projection of the criterion. In any event, once
such an item is classified as air mandatory, proposals to change
such classification should consider the costs of special pro-
visioning if necessary to augment inventory for a sealift pipe-
line. For example, if additional inventory would be necessary,
the item price density used in determining air eligibility
should be adjusted to include the special provisioning costs.

FIGURE 8
IMPLEMENTATATION PLAN
FLOW DIAGRAM
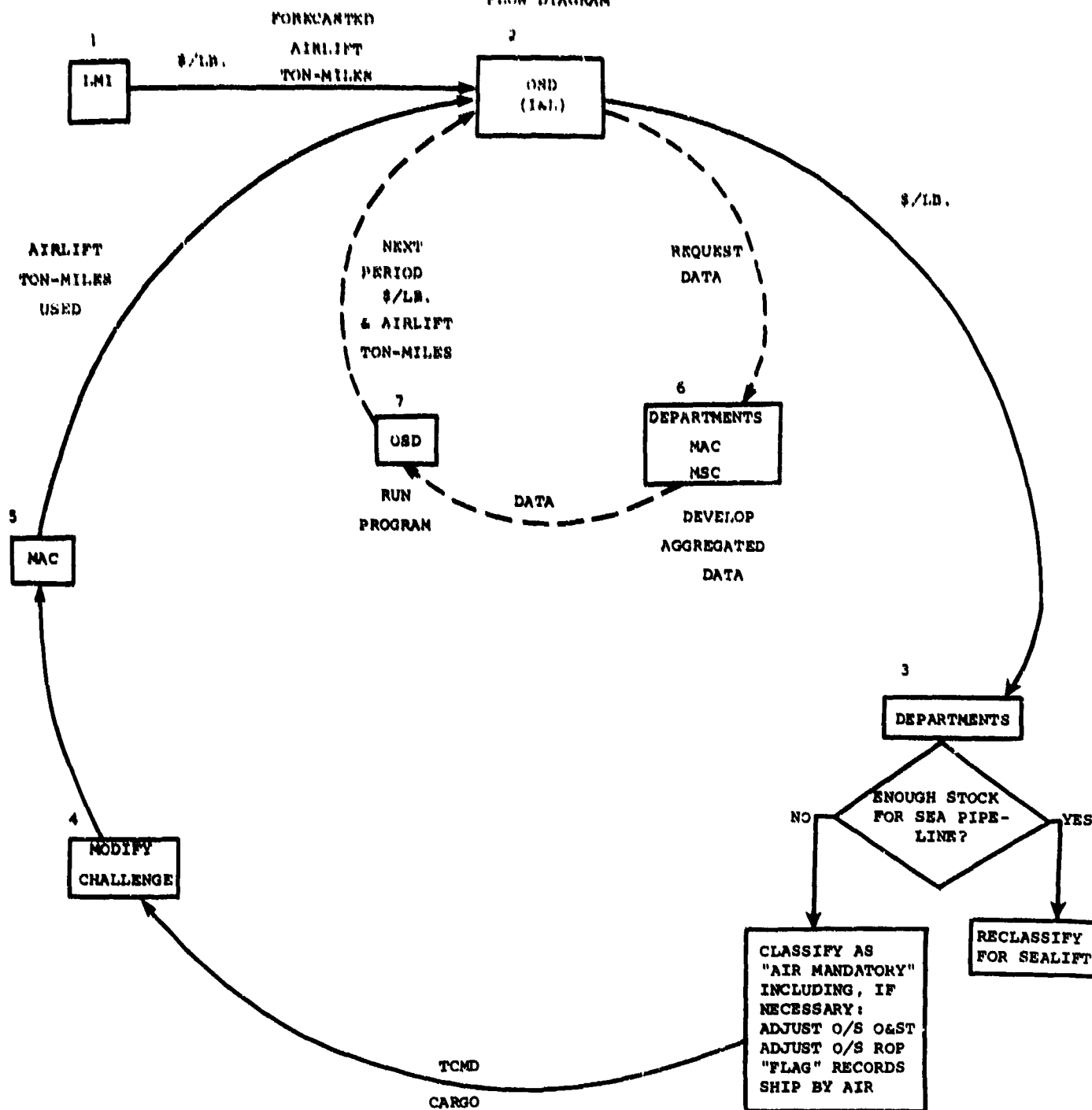
Legend:

Action Loop ————

Analysis Loop ——— —

V. IMPACT OF THE AIRLIFT CRITERION ON RELATED TOPICS

The use of an economic criterion to determine the mode of
intercontinental transportation for DoD cargo has an impact on
a number of related topics. This section discusses several of
the more important of those topics.

A. INDUSTRIAL FUNDS

The use of economic criteria to determine the mode of inter-
continental shipment will change the cash flow through the in-
dustrial funds used by MAC, MSC, and MTMTS. The cash flow
through the airlift fund will increase over prior peacetime
periods. The cash flow for both the sealift and port operations
industrial funds will decrease. These changes will have to be
anticipated by fund managers to insure a proper allocation of
resources and appropriate tariffs.

The cost element structure of the funds need not change
either for the use of the economic airlift criterion or as a re-
sult of the criterion. The various DoD components will continue
to pay the tariffs set by the fund managers for their shipments.
Nevertheless, new values of the criterion will be based on the
incremental costs involved in transporting cargo. Those costs
will probably differ from the tariffs.

B. MILITARY SEALIFT COMMAND

Implementation of the economic air eligibility criterion will
affect MSC operations. Most of the cargo that will be diverted
into the airlift system under economic rules will be "general

cargo," the category that provides MSC with its greatest flexibility in dealing with the variety of contractors, types of ships, origins and destinations, and general route planning. Removing any traffic from MSC will affect its offerings to its contractors. As a result, commercial carriers may cut back on the modernization of their vessels and slow down the procurement of any new vessels that they might be considering.

Use of cargo to finance DoD cargo ship construction has historical precedence. Discussions with MSC indicate that nucleus fleet ship acquisition funds are not likely to be appropriated. Therefore, acquisition could only be financed, as in the past, by carrying peacetime cargo. The Joint Logistics Review Board assumed continued reliance on government-generated peacetime cargo for ship construction financing.[1] Recent hearings on the President's Maritime Program also suggest this use of cargo.[2] However, for any given size of the mobility forces, the least total cost to the DoD occurs when cargo allocation is free of the restriction to support or help support the financing of the mobility forces and their readiness.

To illustrate, at the minimum total cost point in Table 1 (page 25), the sealift intercontinental revenue for the total 500 million short ton-miles diverted to airlift by the economic criterion is $11 million/year.[3] If that amount of traffic is

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[1] Logistics Support in the Vietnam Era, Vol. III, p. 18-7, TR-10.

[2] Hearings before the Subcommittee on Merchant Marine, Committee on Merchant Marine and Fishing, House of Representatives, 91st Congress, 2nd Session, January 28 through March 3, 1970, Serial 91-23, pp. 143 and 311.

[3] Sealift traffic diverted to airlift at the minimum total cost point is 2.2 billion MTM. At .5 cents/MTM (Table 3-19) this yields $11 million revenue.

declared "air mandatory," the amount of savings to DoD in Fiscal
Year 1972 would be $61 million. Thus the $11 million per year
to finance ship operation, construction, and modification would
be at the expense of a potential saving to DoD of $61 million/
year. To put it another way, if the economic airlift criterion
is implemented, $11 million per year could still be assigned to
cargo ship financing and $50 million per year ($61 million minus
$11 million) could be put to use for other purposes.

C. MILITARY VERSUS COMMERCIAL AIRLIFT

The task order asked LMI to consider, in developing the cri-
teria, the "most efficient use of military airlift capacity and
extent of use of commercial airlift." Commercial airlift costs
clearly exceed the incremental costs of military airlift capacity
available within the flying hour program. Since the peacetime
military capacity also exceeds the volume of cargo able to pay
commercial airlift rates,[1] the use of commercial airlift for
peacetime cargo cannot be justified by reductions in DoD operating
costs. There may well be other reasons for use of commercial air-
lift, such as to assure mobilization readiness.[2] That aspect,
however, is beyond the scope of the present task.

We are concerned that the criterion and procedures we propose
can accommodate the addition of rules to include commercial air-
lift in peacetime. Consider, for example, two types of adminis-
trative rules that could be used. One is an arbitrary split
of the cargo between military and commercial airlift,

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[1] See Figure 3 (page 31) where demand able to pay in excess
of commercial rates--about 16¢/STM--totals 100 million STM.

[2] In informal discussions, the Air Transport Association
estimated that it was significantly more costly to procure,
operate, and maintain additional C-5 aircraft than to depend
on an equivalent commercial capability based on a regular
cargo program under CRAF.

similar to the Wilson-Weeks rule now in use by MSC. In that case the supply curve of airlift costs that is used to determine the dollars-per-pound criterion would be a combination of both the military and the commercial costs as illustrated in Figure 9.

Another rule that could be used would be to guarantee to the commercial industry a certain volume of traffic expressed in ton-miles or in dollars. For purposes of air eligibility decision making, the cost of such an arrangement would be considered as sunk, and the commercial ton-miles would appear in the curve of supply costs of airlift at the beginning of the curve followed by the military ton-miles as in Figure 10. The demand curve for airlift is established (also shown on Figure 10). Again (as on Figure 3, page 31), the intersection of the airlift supply costs curve and the demand curve define the minimum total cost operation, the military capacity to be used for "air mandatory" shipments, and the costs of the capacity. Thus, the changes in available capacity of either type of airlift can be examined and the impact determined.

Under both of these rules (arbitrary split and fixed charge) the cost of the commercial airlift would be charged to the individual user via the industrial fund tariff. Of the two rules, LMI believes the "fixed payment" rule is more efficient and provides greater flexibility in handling both military and commercial airlift.

FIGURE 9

ILLUSTRATIVE COST OF AIRLIFT FOR
MILITARY-COMMERCIAL SPLIT IN CARGO
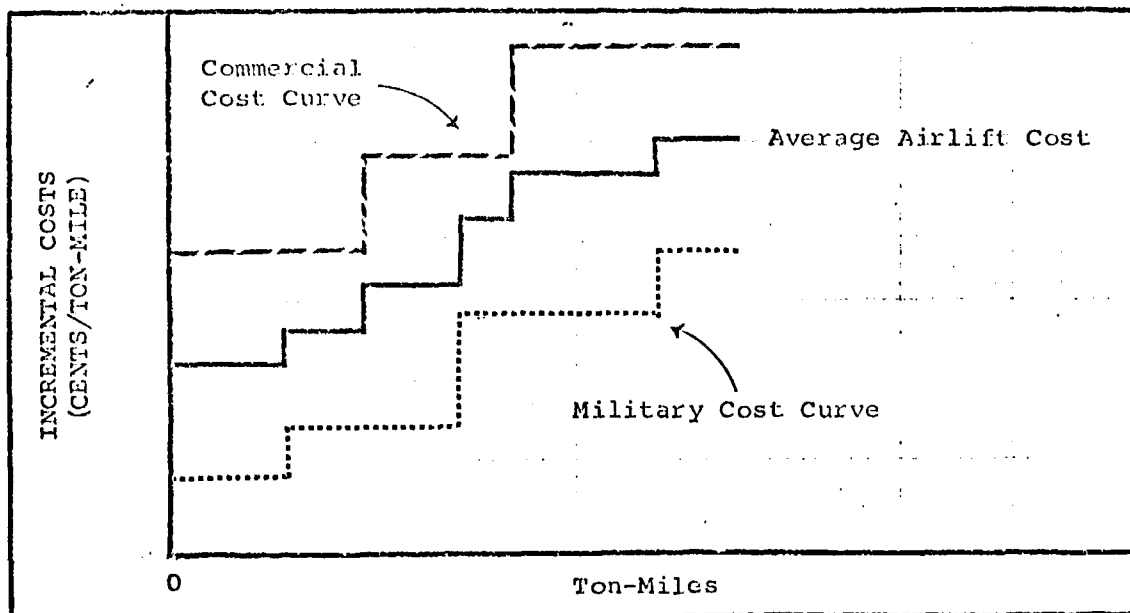
FIGURE 10

ILLUSTRATIVE SUPPLY & DEMAND AIRLIFT CURVES
SHOWING USE OF FIXED PAYMENT RULE
FOR COMMERCIAL AIRLIFT
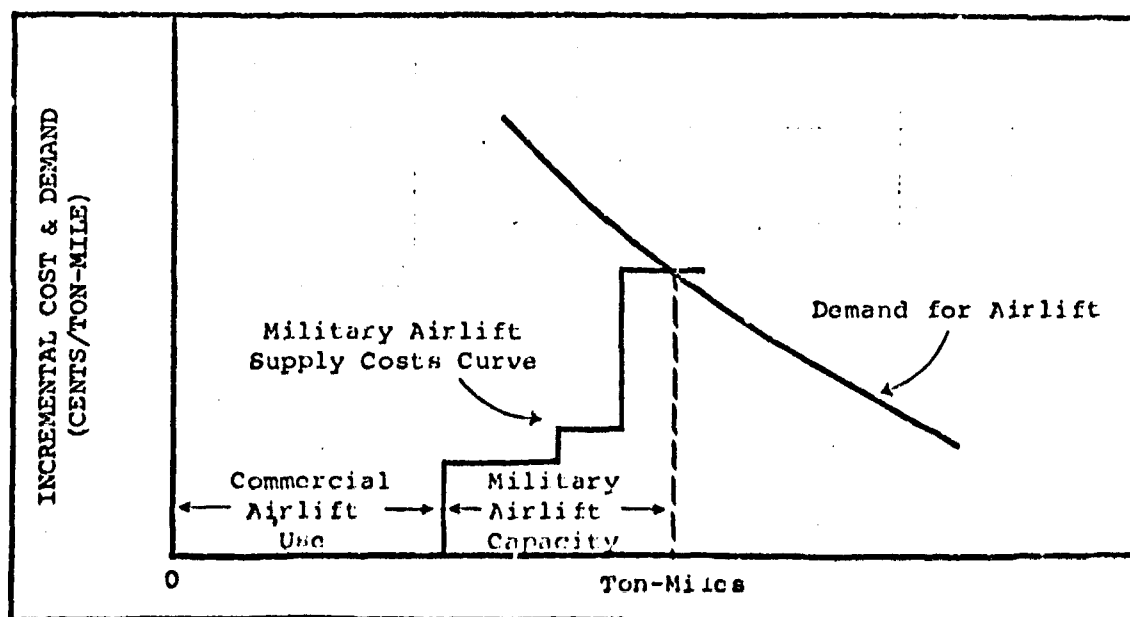
VI. RECOMMENDATIONS

This section presents our recommendations, together with references to the earlier sections where details can be found. The recommendations are grouped in four categories: (a) Implementation of the Economic Criterion, (b) Documentation Revisions, (c) Refinement of Input Data and Formulas, and (d) Related Actions.

A. IMPLEMENTATION OF THE ECONOMIC CRITERION

A significant saving and cost avoidance, approximately $60 million/year or more, can be obtained by using capacity generated by the peacetime flying hour program (page 28). Therefore:

> Recommendation No. 1: An Economic Air Eligibility Criterion should be instituted by OSD.

A simplified criterion has been identified that will recover about 80% of the total potential savings (pages 33 to 37). Accordingly:

> Recommendation No. 2: The criterion which should be used is item price density, or dollars per pound. It should be derived from supply-demand curves for outbound cargo.

Should an alternative criterion be used, it should be one which can be shown to capture more of the total potential savings after factoring in any increased administrative costs (page 60).

A conservative criterion value for dollars/pound (conservative in the sense that less items are classified air eligible rather than more) should be used to minimize costly changes in reclassification (pages 34 to 37). The conservative criterion corresponds to a less than full use of the flying hour capacity. However, much of that capacity can be used and most of the savings obtained a year earlier with such criterion than if implementation was postponed until better criteria values could be developed (pages 41 to 43). Therefore:

> Recommendation No. 3: The criterion should
> correspond to the split of outbound cargo re-
> sulting in minimum DoD cost for the current
> planning period but not lower than $3.86 per
> pound (corresponding to the 1974 inventory
> saving limit point). This restriction should
> continue until data uncertainty is reduced
> to the point where the reclassification risk
> is negligible.

The precise cost calculations are complex and cannot now be supported by equivalently refined input data. Therefore:

> Recommendation No. 4: Economic air eligibility
> criterion calculations should be based on a
> simplified, aggregated formula (page 17).

The major saving results from inventory reduction (page 34). Thus, if an item is expected to remain in surplus during the planned period or its inventory cannot be reduced in that period, there is little point in designating it for airlift. Therefore:

> Recommendation No. 5: All items to be pur-
> chased in the next planning period, and
> held in an overseas depot with a Reorder Point
> responsive to actual Order and Shipping Time,
> which meet the economic air eligibility cri-
> terion, should be declared air mandatory for

routine resupply. All other routine re-
supply items remain or return to sealift.

To assure an up-to-date criterion:

> Recommendation No. 6: OSD annually should
> issue the economic air eligibility cri-
> terion based on calculations using the sim-
> plified formulas (Recommendation No. 4) and
> latest data (Recommendation No. 14). Air-
> lift cargo volume expected to be generated
> by the criterion also should be issued to
> assist in traffic planning. Initial cri-
> terion should be $3.87/lb. and should not
> be effective until the documentation revis-
> ions (Recommendation Nos. 10 through 13)
> have been implemented.

Until accurate retrograde cargo data are available
(pages 63 to 64):

> Recommendation No. 7: The criterion for
> retrograde air eligibility should be the
> same as the criterion for outbound cargo.
> However, until more accurate retrograde
> data are available, retrograde items should
> be airlifted at the option of individual
> Services.

Shelf life items represent increased inventory holding
costs (pages 64 to 66). Therefore:

> Recommendation No. 8: Items in Condition
> Code C (as defined in DoD Instruction
> 4140.27) should be air mandatory. All
> others should be air mandatory if their
> price density exceeds the criterion ad-
> justed as detailed in Section IV (page 66).

An air eligibility criterion should be applied at the time of
initial provisioning in order that the most economical form of
transportation can be identified and reflected in pipeline re-
quirements, and hence on total quantities bought. However,

reclassification (from airlift to sealift) can be unusually expensive. Thus special attention is necessary for these items (pages 67 to 68). Therefore:

> Recommendation No. 9: For the first two
> years provisioning decisions should be based
> on the criterion in force at the time of the
> decisions. Once such a decision has been
> made, proposed reclassification requiring
> additional inventory, should consider
> special provisioning cost if any.

B.   DOCUMENTATION REVISION

Pertinent documents must be revised to permit and encourage the use of the economic criterion. Drafts of the revisions appear in Appendix 4.

> Recommendation No. 10: DoD Directive 4500.9,
> "Transportation and Traffic Management,"
> October 10, 1969. This directive should be
> the basic document for directing the imple-
> mentation of the economic criterion. An en-
> closure to DoD Directive 4500.9 should in-
> clude the basic concept, the method of
> calculating the criterion, and the assignment
> of responsibilities.

> Recommendation No. 11: DoD Instruction 4410.6,
> "Uniform Materiel Movement and Issue Priority
> System (UMMIPS)," 18 February 1971. This
> instruction should be modified to permit
> early Required Delivery Dates for air manda-
> tory cargo.

> Recommendation No. 12: A variety of supply-
> oriented directives and instructions should
> include DoD Directive 4500.9 as a reference.
> Because most of the savings from using the
> economic criterion result from reducing in-
> ventories, supply personnel should understand
> the criterion and its implementation. See
> Section IV., pages 62 to 63, for a list of
> such documents.

Recommendation No. 13: These documents
(directives, memoranda, letters, etc.)
concerned with MILSTAMP challenges should
be reviewed and revised as appropriate to
release air mandatory shipments from the
full range of present challenge factors.

C. REFINEMENT OF DATA AND FORMULAS

There is substantial uncertainty in the data used in calcu-
lations of the air eligibility criterion (page 41). Therefore:

Recommendation No. 14: The data required
for annual application of the air eligi-
bility formulas should be developed by
appropriate DoD components (Appendix 3,
Table 3-17).

We have recommended a conservative criterion value princi-
pally because of the uncertainty of routine resupply capacity in
wartime (pages 18 to 21). Therefore:

Recommendation No. 15: DoD should investi-
gate the cost and capacity of routine re-
supply by airlift in wartime, as data be-
come available.

Many simplifications were made in developing the recommended
formula. These should be verified periodically. Therefore:

Recommendation No. 16: Annually, the data
supporting the formula simplifications
should be spot-checked by the responsible
DoD components and the associated simpli-
fications reappraised by OSD.

D. RELATED ACTIONS

This final group of recommendations covers topics indirectly
involved in the economic air eligibility criterion.

The morale aspect cannot be treated adequately and easily
in an economic framework (pages 66 to 67).

> Recommendation No. 17: The movement of
> passengers and morale items, e.g., mail,
> should not be considered under economic
> rules.

It is insufficient to try to buy readiness with peacetime
cargo. With relatively large savings possible from reduced
inventories, it is more efficient to use economic rules for
transportation mode decisions and use the savings to buy the
necessary posture (pages 71 to 73).

> Recommendation No. 18: The defense posture
> in sealift should not be based on the peace-
> time movement of cargo by the sealift forces.

Since similar logic applies to airlift, procuring a fixed
amount of commercial airlift capability--that is paying a fixed
charge, expressed in ton-miles or dollars--will leave more
options open to the DoD than the Wilson-Weeks type of rule cur-
rently in force for sealift traffic (pages 73 to 74).

> Recommendation No. 19: If commercial airlift
> is to be used for cargo movement, use the
> "fixed charge" rule in place of the Wilson-
> Weeks type rule.

Portions of the distribution system beyond the scope of
this study can be evaluated by air eligibility planning factors.
For example, the cost of obtaining a   day reduction in the
O&ST at a depot or in CONUS transit can be compared with the bene-
fit estimated by the air eligibility calculation procedure (page 41).

> Recommendation No. 20: The outputs from
> calculating the air eligibility criterion
> should be used to help evaluate proposed
> improvement throughout the distribution
> system.

APPENDIX 1

LMI TASK ORDER 70-19

ASSISTANT SECRETARY OF DEFENSE
Washington, D. C.

Installations and Logistics   DATE: 18 March 1970

TASK ORDER SD-271-136
  (Task 70-19)

        1.   Pursuant to Articles I and III of the Department of
Defense Contract No. SD-271 with the Logistics Management Insti-
tute, the Institute is requested to undertake the following task:

            A.   TITLE: Criteria for Airlift Eligibility
                          of DoD Cargo

            B.   SCOPE OF WORK: Present UMMIPS criteria for air-
lift eligibility of DoD cargo deal primarily with priority of
need only and do not consider cost savings and other criteria.
Current criteria may not generate all of the cargo which the 1975
C-5 equipped airlift fleet of MAC is capable of carrying effectively
within the peacetime flying hour program required for essential
training.   Therefore, LMI will examine all categories of peacetime
DoD cargo (from Army, Navy, Marine, Air Force, DSA, MTMTS, etc.)
which might be candidates for transport by airlift and develop
easily applied criteria for choosing the most air eligible cate-
gories from an overall, DoD-wide cost effectiveness standpoint.
The time period to be considered will cover the transition period
from present Vietnam-affected operations up to and including the
peacetime operation of the military airlift fleet as contained in
the approved Major Program Memorandum for Military Forces.

            In developing such criteria, appropriate considera-
tion will be given to:

            a.   Readiness of peacetime forces as affected
                  by availability of critical supply items.

            b.   Potential cost savings from shorter pipe-
                  line and reduced stock level requirements.

            c.   Most efficient use of military airlift
                  capacity and extent of use of commercial
                  airlift.

                                1

d. Degree of cargo unitization.

e. Peacetime requirements for mobility support forces.

f. DoD transport costs.

g. Morale impact of certain personnel items, i.e., mail, perishable foods, etc.

h. Passenger traffic.

i. Retrograde versus outbound traffic.

j. Space available considerations.

k. Impact on MSTS sealift.

2. SCHEDULE: Full cognizance shall be taken of currently completed and ongoing study efforts in this area. An oral progress report will be given within three months, a written progress report after six months, and a final written report completed within twelve months.

/s/ Glenn V. Gibson

ACCEPTED /s/ William F. Finan

DATE   18 March 1970

APPENDIX 2

MODEL DESCRIPTION

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MODEL DESCRIPTION

A. INTRODUCTION

This appendix describes the cost model used to determine the initial air eligibility criterion. Appendix 3 describes the input data calculations and results.

Four previous studies[1] described different mathematical models developed to represent distribution costs. The differences reflected different opinions as to the best way to approximate the real situation. Originally it was expected that results from existing models would suffice for the LMI task. However, it was impractical to use the previous models to test such concepts as incremental cost, wartime demand, or inventory responsiveness. Therefore, a new simplified model was built, based on our evaluations of what simplifications and assumptions were most realistic in view of the nature and quality of available data and the objectives. The new model, while adequate for a first determination of a criterion, should not be used in succeeding years if improved data become available. Sensitivity analysis should be employed annually to determine which of the simplifications and assumptions should be replaced by more refined approaches.[2]

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[1] Two by RAC, one by IDA/WSEG, and one by AFLC. References in body of report, page 4.

[2] See Appendix 3, page 31, for example of such analysis.

1

B.   COSTS

Costs are described in this section in terms of cost elements, the degree of aggregation in the calculations, and the equation.

1.   Cost Elements

The cost elements, together with the variety of ways in which each has been treated in past studies, and in this study, are listed in Table 2-1.

2.   Cost Aggregation

Each item requisitioned from overseas will incur one or more of the costs listed in Table 2-1. Calculating such costs for each requisition is impractical. Calculations were simplified in previous studies by aggregating requisitions, cost factors, or time.

a.   Items of Material

Only IDA among the previous investigators aggregated material items by FSC in their calculations.[1] In each of the other studies the cost to distribute one Federal Stock Number (FSN) was obtained individually, not as a member of a group or class. However, because of the quality of currently available data, calculations on individual FSNs to determine air eligibility criterion probably yield no better criterion value than if the material items are aggregated. Available data are inaccurate and incomplete. The previous study groups went to great length to supplement missing data and correct data as necessary. Nevertheless, the resulting data were suspect. For example, some Federal Stock Classes (FSCs) are listed at less than 0.5 pounds per cubic foot which is less than the density of empty cartons.

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[1]Cf. R. F. Stryker et al., op. cit., Vol. 1, pp. 184-185.

TABLE 2-1

<u>COMPARATIVE TREATMENT OF COST ELEMENTS</u>

NOMENCLATURE OF COST ELEMENT OR FACTOR	TREATMENT OF COST ELEMENTS (AND NOMENCLATURE IF DIFFERENT) BY PREVIOUS ANALYSTS				LMI TREATMENT
	RAC		IDA	AFLC	
	First	Second			
Packing	Included (Final destination consideration explicitly omitted)	Included as Packaging Differential	Considered not significant for air eligibility decision	Included as Packaging	Sea Packing Considered generally more costly than for air
CONUS Inland Haul	Included in Inland Haul	Included in Surface Transportation	Included as CONUS Line Haul	Included as CONUS Inland Line Haul	Assumed negligible
Port Handling (CONUS & O/S)	Included as Intransit warehousing & port handling	Included in Surface Mode	Included as CONUS Port Handling & O/S Port Handling	Included as Warehousing & handling (zero for airlift)	Included
Intercontinental Haul	Included as Line Haul	Included for Air Transportation Sealift is in "Surface Transportation"	Included as Intercontinental Transportation	Included as O/S Line Haul	Included
O/S Local	Included in Inland Haul	Included in Surface Transportation	Included as O/S Line Haul	Included as O/S Inland Line Haul (Zero for Airlift	Assumed negligible
Inventory One-Time Saving	Omitted	Included as Pipeline & Inventory Cost Avoidance	Included in Annual Inventory Cost Factor	Included as Inventory Pipeline Investment	Included in Annual Saving
Annual Inventory Savings	Included as Inventory Maintenance Cost	Included as Holding Cost Avoidance	Included in Annual Inventory Cost Factor	Omitted	Includes Amortization Annual Saving
Loss & Damage	Loss & Damage Included	Omitted because considered part of annual inventory	Omitted because considered part of annual inventory	Included as Loss & Damage	Omitted because considered part of annual inventory
Aggregated Cost Factors	No	Yes	Yes	Yes	Yes
Mobilization Reserve	Omitted	Omitted	Discussed in Vol. 1, p. 63, but not in formula	Omitted	Allowances made
FSN Aggregated	No	No	No	No	Yes

SOURCE:

1. **First RAC:** RAC-R-64, "Economic Use of Military Airlift and Sealift for Overseas Shipment in Peacetime," Volume 1, January 1969, Lawrence G. Regan, et al.

2. **Second RAC:** RAC Study 010.113, "A Methodology for Selecting Items for Air Shipment on an Economic Basis," 30 April 1970, Ray M. Clarke, et al.

3. **IDA/WSEG Report 141,** "Resupply in Peace and War by C-5 Airlift and by Containership," July 1969, R. P. Stryker, et al.

4. **Air Force Logistics Command,** "The Economics of Cargo Shipment, Airlift versus Sealift," Air Force Logistics Studies, Airlog 70 Phase III Report, January 1969.

Therefore, LMI based its calculations on an over-
seas cargo shipment data base which was aggregated by FSC. We
assumed that the data aggregated by FSCs represented the distri-
bution of overseas cargo characteristics and volume only, not
necessarily the actual identity of the FSCs. The true identity
of the FSC would have been important only if transportation
mode classification of the classes or items was involved at
this step. However, as explained in Section IV of this report,
mode classification is done on individual FSNs after the cri-
terion has been calculated (Step 3, Figure 8).

b. Cost Factors

In most prior studies there was a high degree
of aggregation of the cost factors. That is, the cost to ship
a ton of aircraft engines one mile was assumed to be the same
in the Pacific as it was in the Atlantic and it was the same as
a ton of radio parts. Only the first RAC study distinguished
among port-to-port cost variations and among commodity cost
variations. All other studies aggregated shipping costs. Some
of the studies distinguished the packing cost differentials by
material category. The first RAC study distinguished these
differentials by FSC.

Thus there was a considerable range in the degree
of aggregation among the studies. However, the maximum degree
of aggregation used in the previous studies appears the most sens-
ible, given the accuracy of currently available data. For ex-
ample, packing data are extremely inaccurate, as discussed
earlier.[1] There is even some evidence that the difference be-
tween packing for air and sea is zero. Thus, we see no point
now in using more than one packing cost factor for air and one

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[1]Page 44.

for use for all commodities. For another example, ocean shipping costs vary considerably from port-to-port and commodity-to-commodity. However, economic air eligibility classification is relatively insensitive to wide variations in ocean shipping costs.[1] Accordingly, we believe a single worldwide rate is appropriate.

c. Time

In general, the increase in annual air shipping charges is offset by an initial decrease in stock, plus certain annual benefits. This can be expressed in equation form as:

$$Y = A - \sum_{i}^{N} (B_i - C_i) \ (1 + r)^{-i + 1} \tag{1}$$

where Y is the present worth cost advantage to airlift an item for the N years that the item is in inventory, A is the cost saving of the initial stock decrease, B_i is the increase in transportation costs in the ith year if the item is airlifted, C_i is the benefit in the ith year, and r is the discount factor. In determining if Y is positive (i.e., the item should be airlifted), one can make the indicated calculation or alternatively aggregate by estimating an average for B_i and C_i over the N years and then combine by annuity factors, as:

$$Y = A - (\bar{B} - \bar{C}) \ \left(\frac{1 - \left(\frac{1}{1 + r}\right)^N}{r} \right) \tag{2}$$

Again, the accuracy of the available data encourages use of the latter form to determine the criterion.

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[1] The earlier RAC study does not support this view because the air density break point was not used. See, however, Table 3-22, Appendix 3, where the sensitivity of the number of FSCs at the inventory limit point is tabulated. Since the ranking of FSCs was unchanged, the invariance in the number of air eligible FSCs is indicative of low sensitivity.

3. Cost Equation

We will start with a complete cost equation for calcu-
lating an economic air eligibility criterion and, step-by-step,
strip away those terms which have a negligible influence on the
criterion.

The cost of transportation is generally considered to
depend on the distance traveled and the volume, weight, and
nature of the item. For the aggregation employed by LMI, the
cost factors neglect the nature of the item. The inventory costs
are proportionate to item price and time in transit (which we
assume fixed for each transportation mode). Thus the cost
equation may start with terms proportionate to volume, to weight,
to price, to a product of intercontinental distance and weight,
to a product of intercontinental distance and volume, and a
constant to represent administrative fixed costs such as the
cost of reclassifying from airlift to sealift:

Distribution Cost = D · ton-miles + E · volume-miles

+ F · weight + G · volume + H · price + I   (3)

where D, E, F, G, H, and I are cost coefficients which would
differ for sealift and airlift, and which are discussed in
detail below.

Port handling and packing costs do not depend on inter-
continental distance. Intercontinental haul costs are primarily
proportional to a product of distance and weight or volume.
Hence we relate the coefficients in equation (3) to the cost
elements in Table 2-1 as follows:

D and E depend only on Intercontinental Haul costs,

F and G depend only on Packing and Port Handling costs, and

H depends only on Inventory Savings.

Furthermore, the intercontinental haul costs are based on a designated minimum density. Hence the first and second terms of equation (3) may be changed to the form:

$$M \cdot \text{Maximum } (D \cdot W, \ E \cdot V),$$

where M is the intercontinental distance in miles, W is the weight in tons, and V is the volume in cubic feet.

The bulk of general cargo is between 10 and 50 pounds per cubic foot. Sealift charges are based on the assumption that the density of each shipment is at least 50 pounds per cubic foot. Therefore, $F \cdot W$ is generally less than $G \cdot V$ for sealift and we may assume, with negligible error, that $F = 0$ for sea shipments. Airlift costing is based on the assumption that density is at least 10 pounds per cubic foot. Since most items exceed that density, we may assume, with negligible error, that $G = 0$ for airlift.

Inventory costs are based on the shipping time reduction of airlift vs. sealift; in other words, only the differential is of interest. Hence for airlift, inventory costs are considered zero, i.e., $H = 0$. For sealift, "H" will represent only the extra costs associated with the increased pipeline required for sealift. The dollar value of the inventory cost differential is proportional to the (1) annual dollar value of the goods shipped, (2) reduction in shipping time between sealift and airlift, and (3) annual value that the reduction of one dollar in inventory is worth. The first two elements--dollar value shipped and reduction in shipping time--are required as input data. The last element--the annual value of an inventory reduction of one dollar--may be related to equation (2).

First divide Y by the annuity factor to get an annual benefit--
y, and eliminate $\bar{B}$ since $\bar{B}$ is not related to inventory:

$$y \ \alpha \ \left[\frac{A}{\left[\dfrac{1 - \left(\dfrac{1}{1+r} \right)^N}{r} \right]} \right] + \bar{C} \tag{4}$$

Next factor out A, which is the price reduction of the initial
stock decrease:

$$y \ \alpha \ \left[\frac{r}{1 - \left(\dfrac{1}{1+r} \right)^N} + \frac{\bar{C}}{A} \right] \cdot A \tag{5}$$

A is the product of annual dollar value shipped and reduction in
shipment time, and it includes item price. Hence the term
"H · Price" in equation (3) may be replaced with "y" from equation (5)

The first part of the coefficient of A is an annuity
term and requires for input only the discount factor r and life,
N. The second part of the coefficient, $\bar{C}/A$, is the ratio between
annual inventory savings and the price of the causal reduction
in inventory. This ratio must be supplied as an input value.
For convenience let "J" be the coefficient of A, and rewrite
equation (5):

$$y \ \alpha \ JA \tag{6}$$

In accordance with the discussion in the body of the
report, the pipeline cannot be reduced for those items not air-
lifted because of wartime requirements.[1] For such items J = 0
for sealift, hence in general J is also dependent upon airlift
cargo volume.

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[1]Cf. page 18.

I of equation (3) is the cost to reclassify an item, either from airlift to sealift or vice versa. Ordinarily this cost will be negligible compared with the other costs. However, for some special items production of which involves a large start-up cost, such as airframe components on a phased-out production line, the cost of reclassifying will be significant.

The equation for DoD distribution costs used to determine an air eligibility criterion cannot single out individual factory phase-in costs and other fixed costs of reclassification. Accordingly, we assume that $I = 0$ for calculating the criterion. It is a different matter in classifying individual items (Step 3 of Figure 8 in the body of the report). If there are unusual costs to reclassify an item which are not proportional to the amount of inventory adjustment item price density should be adjusted to reflect such costs. The adjusted price density should be the one tested against the current air eligibility criterion.

The distribution cost equation (equation (3)), then takes two forms. One is for airlift:

$$Z_A = M \cdot \text{Max} (D_A \cdot W, E_A \cdot V) + F_A \cdot W, \tag{7}$$

where subscript "A" refers to airlift data. The second form is for sealift:

$$Z_S = M \cdot \text{Max} (D_S \cdot W, E_S \cdot V) + G_S \cdot V + J \cdot A \tag{8}$$

where subscript "S" refers to sealift data.

The coefficients D_A and E_A are functions of the total cargo volume. This follows because the DoD's incremental cost to transport cargo in aircraft which are not fully loaded and

are flying channel routes because of the flying hour program,
is very much less than the incremental airlift costs for cargo
which requires scheduling flights solely for the cargo.[1]

The savings (if any) for airlift follow from equations
(7) and (8). For simplicity in exposition we assume $E_A = 0 = D_S$.[2]
Then the savings, S, are:

$$S = Z_S - Z_A = (M \cdot E_S \cdot V + G_S \cdot V + J \cdot A)$$

$$- (M \cdot D_A \cdot W + F_A \cdot W) \qquad (9)$$

To assure that each unit of airlift capacity is used by the items
with greatest saving, we wish to assign highest economic rank to
those items whose savings per unit of capacity, S', is highest.
Thus, since capacity is measured in ton-miles (= M · W) we re-
write equation (9):

$$S' = \frac{S}{M \cdot W} = \frac{E_S \cdot V}{W} + \frac{G_S \cdot V}{M \cdot W} + \frac{J \cdot A}{M \cdot W} - D_A - \frac{F_A}{M} \qquad (10)$$

Further, since D_A (the airlift intercontinental rate per ton-
mile) is not fixed throughout the relevant range of airlift
capacity, the expression $D'_A = S' + D_A$ is useful as given in
equation (11):

$$D'_A = S' + D_A = \frac{E_S \cdot V}{W} + \frac{G_S \cdot V}{M \cdot W} + \frac{J \cdot A}{M \cdot W} - \frac{F_A}{M} \qquad (11)$$

To use each successive increment of airlift most
economically, the item with the next greatest saving per unit

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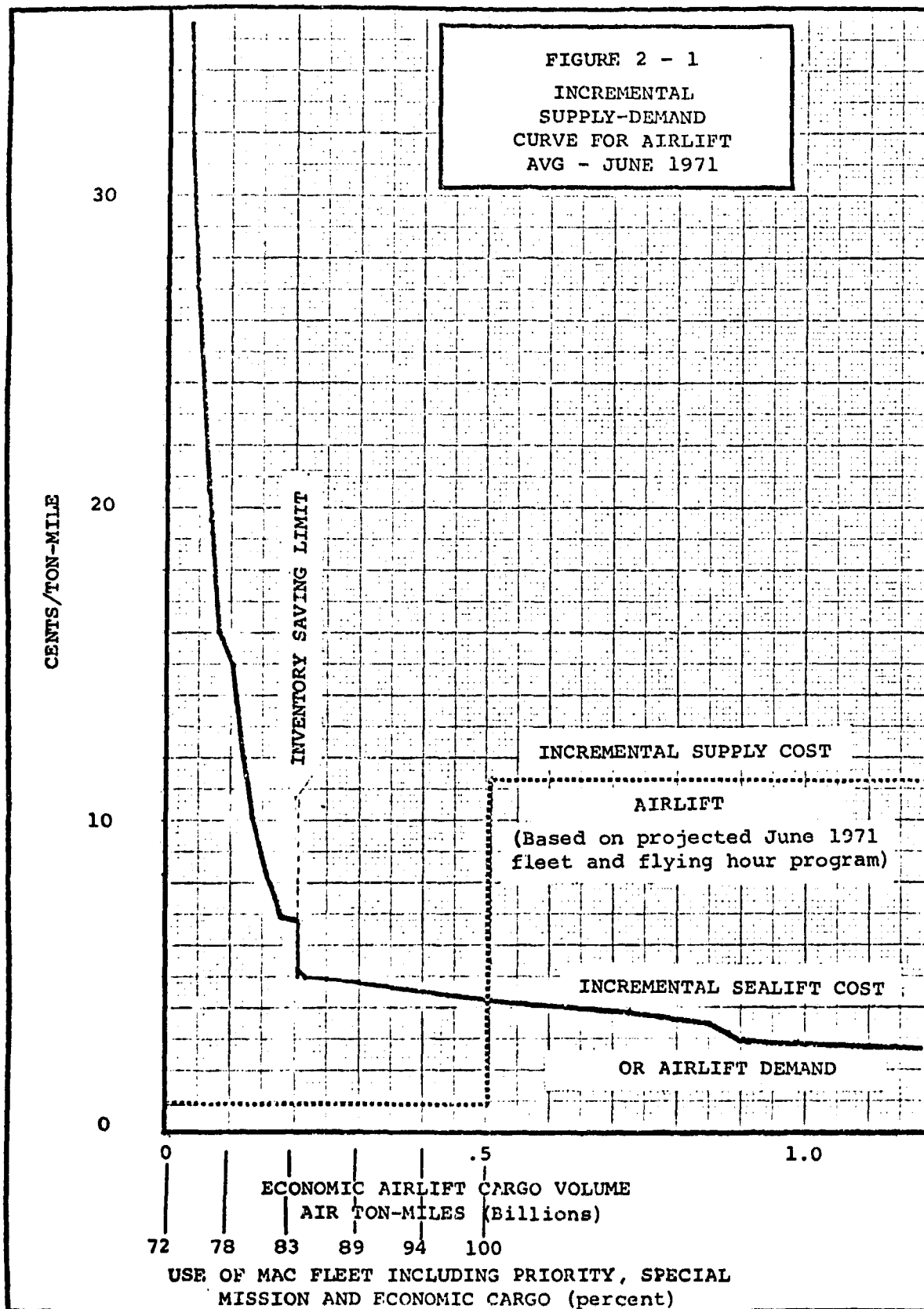[1]Figure 1 (page 23) shows the incremental cost function.

[2]The programing LMI used makes the necessary allowance for
E_A and D_S being non-zero.

of capacity, S', should be added to those already selected for airlift. For each such increment, cargo volume is cumulated by the volume of items already selected for airlift. Hence the value of D_A for that next increment is determined regardless of which item is selected next. Consequently, the item (not already selected for airlift) with the largest D'_A is also the item with the largest S'. Thus the maximum economic benefits from use of airlift are obtained if (1) items are ranked in accordance with D'_A of equation (11), and (2) items are selected from the top of the list until $D_A = D'_A$, i.e., S' = 0, or there is no benefit from further use of airlift. Note that D'_A is the maximum airlift rate which the item can be charged and still break even.

C.   CALCULATING PROCEDURE

There are three steps to calculate the criterion for maximum economic benefits. First equation (11) is solved for each item or aggregation of items. Next, the items are arranged in descending order beginning with that with the greatest D'_A. Lastly, D'_A of the highest item in the list not already classified as air eligible, is compared with the value of D_A for the amount of airlift cargo cumulated from the items higher in the list. If $D'_A > D_A$, the item is called air eligible and its cargo volume is added to that already cumulated. The last iterative step terminates at the point where $D'_A \leq D_A$.[1] This is shown on Figure 2-1 where the airlift cost curve intersects the sealift

---

[1] At the cargo volume where wartime capacity is limiting (called the inventory saving limit), a refinement is introduced in equation (11). As explained on page 2-8, we let J = 0, and recalculate D'_A for the items lower on the list and rearrange that part of the list.

FIGURE 2 - 1

INCREMENTAL
SUPPLY-DEMAND
CURVE FOR AIRLIFT
AVG - JUNE 1971

CENTS/TON-MILE

INVENTORY SAVING LIMIT

INCREMENTAL SUPPLY COST

AIRLIFT

(Based on projected June 1971
fleet and flying hour program)

INCREMENTAL SEALIFT COST

OR AIRLIFT DEMAND

ECONOMIC AIRLIFT CARGO VOLUME
AIR TON-MILES (Billions)

USE OF MAC FLEET INCLUDING PRIORITY, SPECIAL
MISSION AND ECONOMIC CARGO (percent)

cost curve. At that point the volume of cargo, the value of air eligibility criterion and the total saving may be derived.[1]

D. EASILY APPLIED CRITERION

Ordering by D'_A results in maximum savings and hence is a standard against which we compare alternative criteria. However, equation (11) contains many terms, few of which are available to any one person, such as a requisitioner. The natural question is: Is there an easily applied criterion of comparable efficiency? The answer is yes. The logic is summarized next and calculations supporting the answer are detailed in Appendix 3.

Previous studies have shown that inventory savings far exceed all other savings combined. This corresponds to the third term in equation (11), namely, $\frac{J \cdot A}{M \cdot W}$. Furthermore, the accuracy of currently available data allow us to fix J and M by aggregation. Hence D'_A is almost directly proportional to $\frac{P}{W}$, that is, the price of an item divided by its weight (dollars/pound). This piece of data is more readily available.
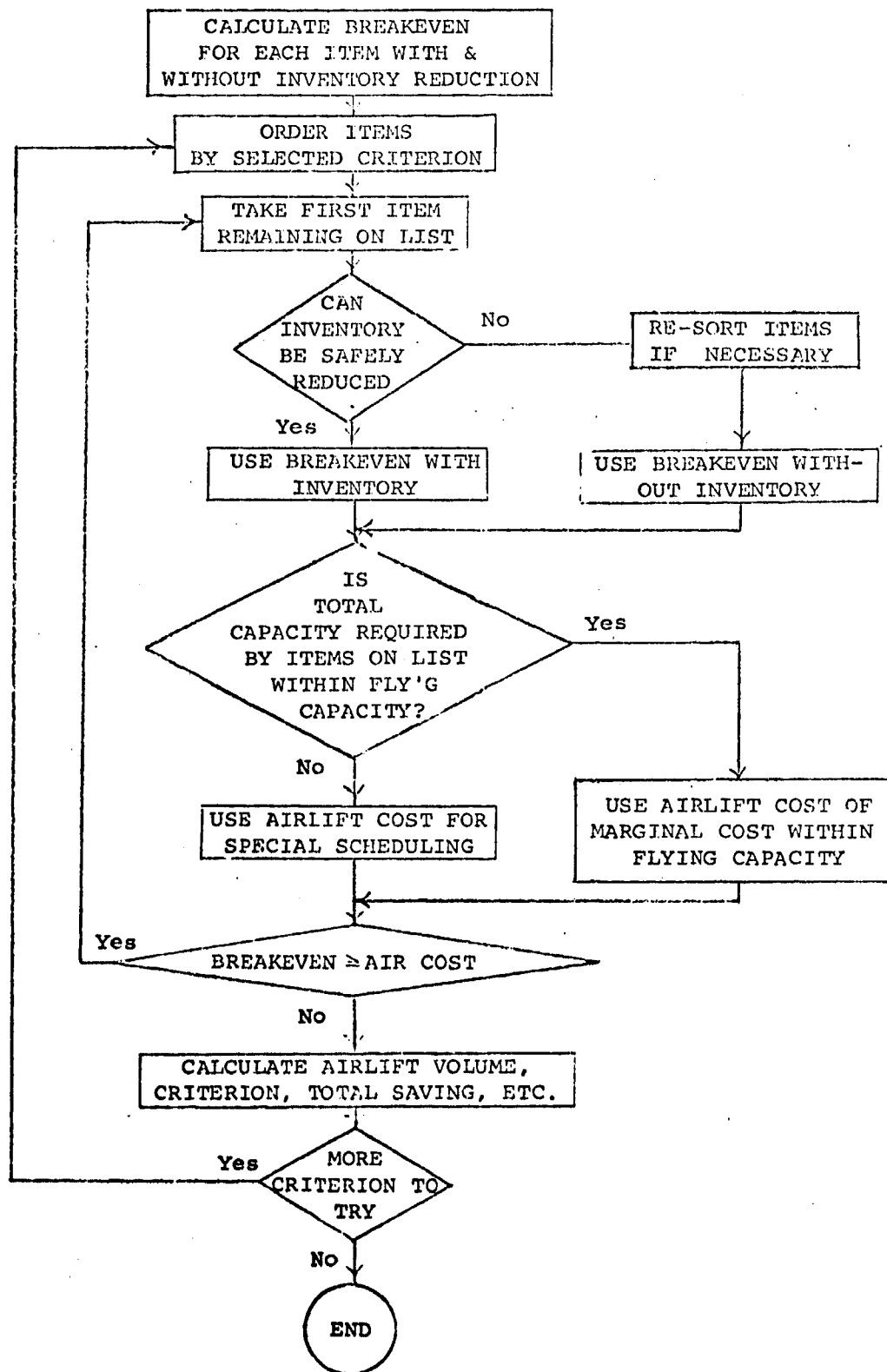
In order to test this, or any other criterion, it is only necessary to arrange the list of items beginning with the items which have the largest value of the trial criterion. Then the same iterative process used above is adapted slightly, as follows: The saving, S, is calculated from equation (9) and cumulated until it is clear that the maximum S has been obtained.

---

[1] The net savings of increasing or decreasing the flying hour program can be estimated also with Figure 2-1. For example, assume an increased program. Move the vertical line in the supply curve to the right to represent the additional flying hour capacity. The area above the demand curve, below the supply curve, and between the old and new positions of the vertical line represents the approximate net cost increase to DoD.

The value of the criterion for the item at which S is maximum
in this cumulative process defines the best criterion value.
A comparison between the maximum saving, which occurs at that
criterion value, with the maximum saving obtained by the
original criterion becomes a measure of efficiency.

The flow diagram of Figure 2-2 summarizes the procedure.
Complete documentation of the program used by LMI in the
calculations are on file at LMI.

FIGURE 2-2

FLOW DIAGRAM OF
SIMPLE AIR ELIGIBILITY CRITERION

APPENDIX 3

CALCULATIONS

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CALCULATIONS

A.   INTRODUCTION

This Appendix describes the calculations used to determine the value of the economic air eligibility criterion. Those calculations were made for the period June 1970 to June 1974. This period will be a transition period as Vietnam-affected operations are phased out, the C-5 is added to the MAC fleet, and presumably economic air eligibility procedures are phased in. Calculations also included sensitivity or error analysis in order to provide some idea of the likely range of the resulting criteria throughout the period. The general formulas given in Appendix 2, namely equations (7) and (8), and the procedure described there are the basis for the calculations described in this Appendix. The input data, output data (including sensitivity analysis), and data sources are presented.

B.   INPUT

The sources of the data and the analysis of and calculations performed on the input data to convert them into coefficients of the formula, are described below under the various cost element categories.[1]

1.   Cargo Volume and Characteristics

Estimates of cargo volume have ranged widely. Both war and peace rates are important as discussed previously.[2]

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[1]All cost data are in constant dollars as of June 1970.

[2]See pp. 18-21.

A sample of peacetime estimates and their sources is found in Table 3-1.

TABLE 3-1

PEACETIME CARGO ESTIMATES

Billion Short Ton-Miles Outbound	SOURCE
32.3	Calculated from "Alternative Sealift Programs for 1975-1984 Deployment Situations (Sealift 75-84), Integrated Sealift Study," Department of the Navy, Office of the Chief of Naval Operations, Deputy Chief of Naval Operations (Logistics), 4 November 1970, Vol. 1, p. I-42. (S)
19.0	RAC-R-64[a]
14.2	Pro rata from MSC Dry Cargo Traffic Carrier Figures for FY 1965
[a]Full citation in footnote 2, p. 4.	

Other estimates have been used by the Army and Air Force, based on recent data. All figures suffer from one or both of two deficiencies: (1) the base data are six years old or more, or (2) the base data represent a contingency period. Both deficiencies mean the type and volume of cargo are not representative of peacetime. Technological changes in six years, for example, may have radically changed the mix and quantity of traffic.

Most users have recognized these problems and attempted
to compensate, but the range shown in Table 3-1 indicates the
uncertainty. For purposes of testing the LMI model and develop-
ing initial (first year) criteria values, we have assumed a mid-
point volume close to the RAC figure, namely 18.4 billion short
ton-miles and a tolerance, ± 20%, which almost covers the lowest
estimate in Table 3-1.

The characteristics of the cargo used in the calcula-
tions have been determined independently of the volume. The
distribution of characteristics was determined from the Federal
Supply Class (FSC) data base of the first RAC study, primarily
because of its convenience. Table 3-2 summarizes the totals of
the cargo volume data used in the LMI calculation.

TABLE 3-2

SUMMARY CHARACTERISTICS OF DATA BASE

Tons, Millions	1.409
Cubic Feet, Millions	96.36
Ton-Miles, Billions	8.170
Value, $ Billions	2.424
Number of FSCs	307

Details on the distribution of characteristics have been
described in the RAC report.[1] The data base resulted from a
compilation by FSC of available FSN individual overseas

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[1] RAC-R-64, Op. cit., Vol. 1, pp. 61-71. Total ton-miles
differ from Table 3-1 since Table 3-2 contains totals of FSCs
for which complete data were available and only of the 307
largest FSCs. Data on over 300 other FSCs were not used to
represent the distribution. Individually, the largest of the
FSCs dropped amounted to less than 0.1% of the total and
collectively those dropped accounted for less than 34% of the
total.

shipment data.[1] A few categories had unusual values, e.g., the density for one FSC was 0.43 lbs./cu.ft., which is less than the density of an empty carton.   Such FSCs were not used.

No detailed estimates of either the volume or character of retrograde cargo movements were developed because data on this category were even more intractable.

The estimated ratio of wartime cargo to peacetime cargo ranges from 1.4:1 to 3.3:1, as shown in Table 3-3, with an average of about 2.5:1. We used a range of 2.1 to 2.9.

TABLE 3-3

ESTIMATES OF RATIO OF WARTIME TO PEACETIME CARGO

RATIO (War Cargo Volume to Peace Cargo Volume)	SOURCE
2.8 1.8	Max Min From "SUPAR" Printout[a]
3.3 1.4	Max Based on NAVSUPINST 004440.151, Min "NAVSUP Interpretation of Logistic Guidance for Use in War Reserve Requirements Deter- mination for NAVSUP-Managed Material," 15 July 1970
2.9	Ratio of traffic reported by MSC in FY 1968 to that reported in FY 1965

[a]"Cargo Characteristics of Resupply Requirements for ROAD (Reorganized Army Division) Division," by L. Christensen, R. Ahlfeldt, L. Garfield, K. Harms, G. Hockey, M. Pollack and R. Wise, Report #PRC-R-1289, 15 November 1969, Contr. #F18600-69-C-0062, Sponsored by Directorate of Analysis, DCS/Dev. Plans, Headquarters, AF Systems Command.

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[1]Ibid., as appearing in Computer Report #7, illustrated in Vol. 2, p. 145, Table D8.

2.   Sealift Intercontinental Rates

MSC data were used for sealift rates. Figures sum-
marized in the MSC FY 1968 financial statement show 0.478
cents/measurement ton-mile (MTM) for FY 1968.[1] Six-month figures
show rates in excess of 0.6 cents/MTM. We took these two figures
as lower and upper bounds for June 1970. For December 1974 the
lower bound was reduced by 62% to 0.184 cents/MTM, based on data
presented by R. P. Holubowicz.[2] The upper limit was left un-
changed. We worked in constant dollars, i.e., no inflation.
These points are plotted on Figure 3-1, together with straight
lines between them to show data used in intervening periods.

3.   Airlift Intercontinental Rates and Capacity

Data on airlift rates and MAC's capacity were derived
from several sources, assuming that representative figures could
be based on a fleet of 16 squadrons of C-141s and the projected
schedule of C-5 additions to the fleet given in Figure 3-2.

a.   Capacity

Capacity of the C-141 fleet within the flying
hour program was based on the assumptions shown in Table 3-4.
Capacity of 27 C-5s, the projected figure for June 1971, was
calculated as shown in Table 3-5. Similar calculations for the
C-5 for later years were made assuming aircraft quantities as
given in Figure 3-2.

---

[1]"MSTS Financial Statement," December 1968, Office of
Comptroller.

[2]"The Other Revolution," U. S. Naval Institute Proceedings,
October 1970, p. 46.

FIGURE 3-1. ASSUMED SEALIFT COSTS

FIGURE 3-2. ASSUMED NUMBER OF C-5'S IN MAC FLEET
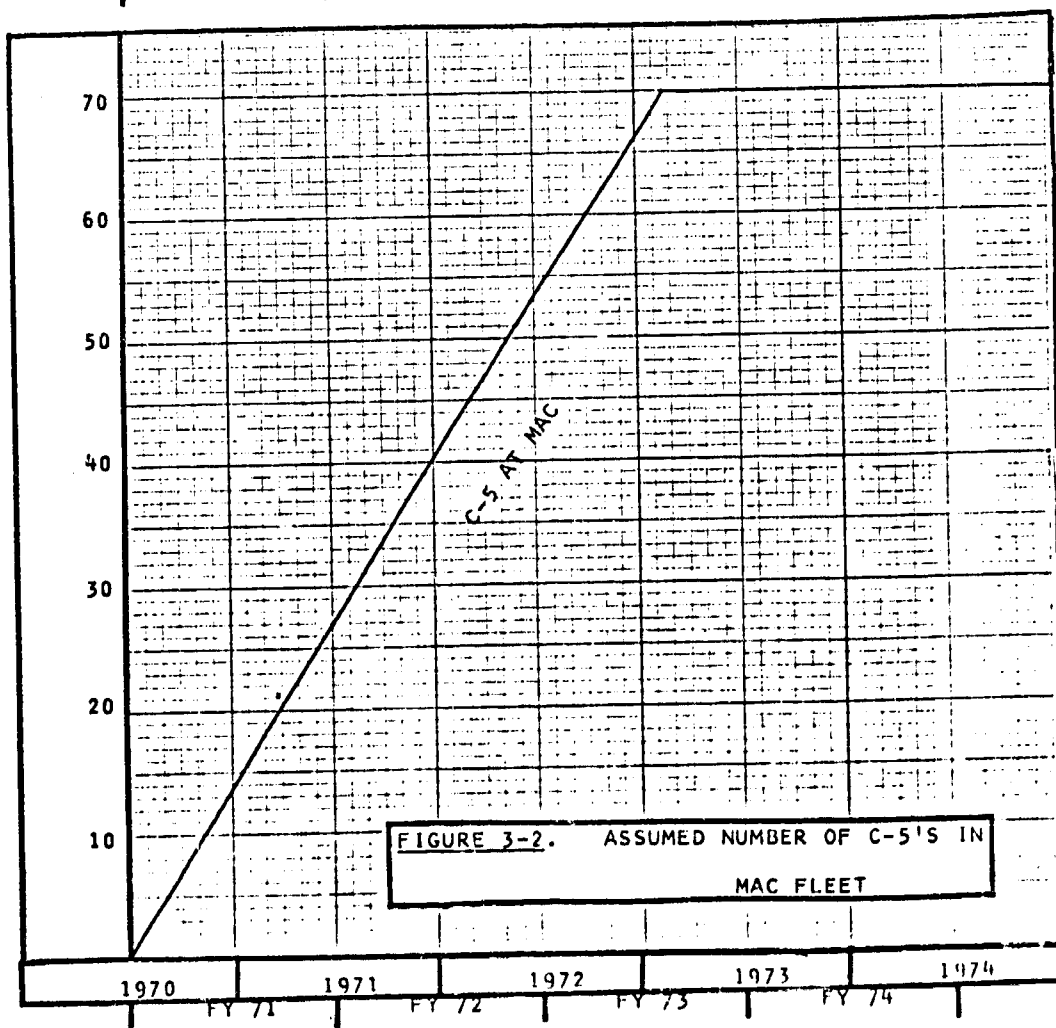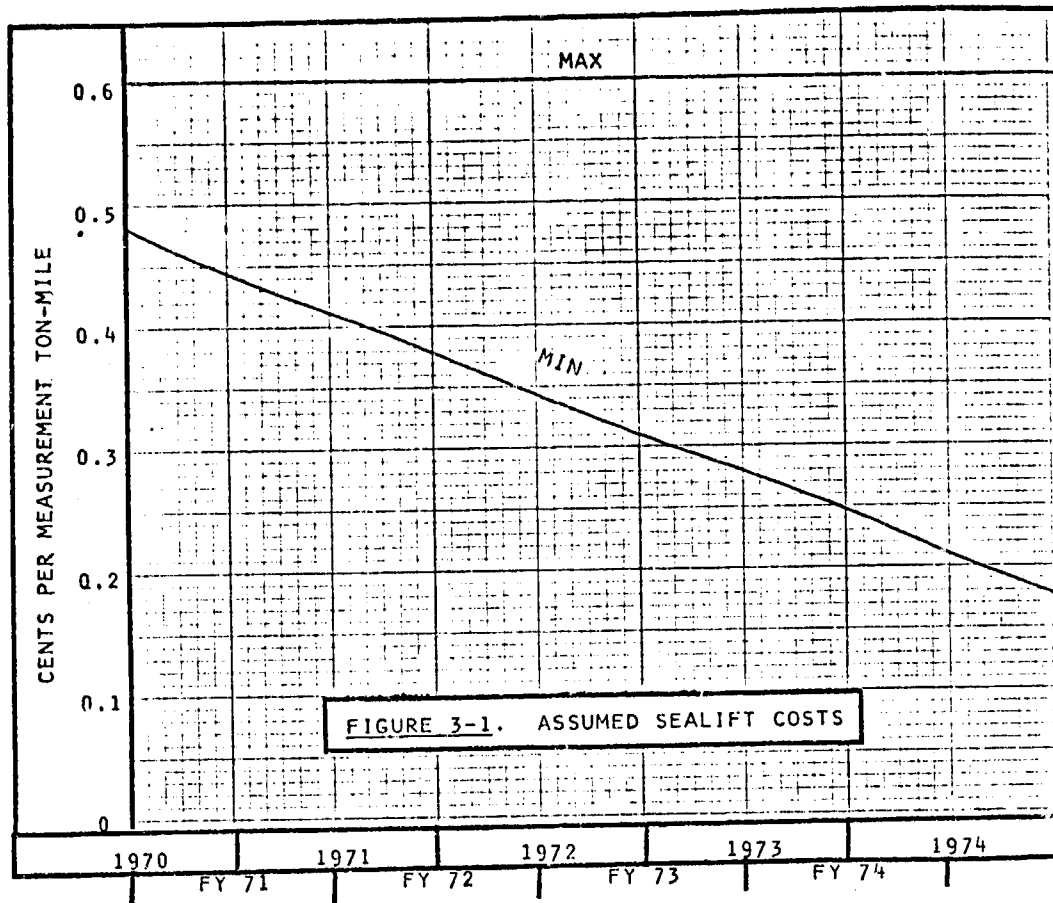
TABLE 3-4

CALCULATION OF FLYING HOUR PROGRAM
CARGO CAPACITY OF C-141 MAC FLEET

	Minimum	Maximum
Allowable Cabin Load (ACL)	24.6 ST	24.6 ST
Block Speed	382 MPH	382 MPH
Flying Hour Program[a]	4.5 hr/day	4.75 hr/day
Special Missions, etc.[b]	2.0 hr/day	2.0 hr/day
Difference	2.5 hr/day	2.75 hr/day
Days/Year	365	365
Number of Aircraft	224	224[c]
% of Capacity Outbound ($\frac{1}{2}$ of Flying Hour Program)	50	50
% Load Factor[d]	77.5	77.5
% Effectiveness Due to Circuitous Routing, etc.	77[e]	100
Product in Million STM/Year[f]	573	819

[a]Latest available information indicates approximately $4\frac{1}{2}$ hour program approved. These figures are not in the product at the foot of the table.

[b]FY 1964 statistics from MAC Airlift Data Summaries show 912 million STM and 1,934 million STM for Special Assignment-Airborne Troop Exercises (SAA-EX/ABT) and total military capability respectively. Assuming a 4.5 hour flying program and that capability is proportional to time, then 2 hours would be required for SAA-EX/ABT. FY 1969 figures are 1,532 and 5,946 respectively. Assuming an 8 hour program again yields 2 hours. These figures are not in the product at the foot of the table.

[c]224 is from IDA/WSEG Study, Vol. 1, p. 34. Actual fleet is now 234 and would change 819 million STM/year to 855 million STM/year.

[d]Load Factor in FY 1965.

[e]Based on letters from MAC.

[f]These figures are the product of all previous figures in the column except "Flying Hour Program" and "Special Missions, etc."

TABLE 3-5

CALCULATION OF FLYING HOUR PROGRAM
CARGO CAPACITY OF C-5 MAC FLEET

June 1971

	Minimum	Maximum
Number of Aircraft	27	27
Allowable Cabin Load (ACL)	87.3 ST	87.3 ST
Block Speed	402 MPH	402 MPH
Other Factors as on C-141 Calculation (Table 3-4)	——	——
Product in Million STM/Year	258	369

The total capacity in June 1971 of the combined
C-141 and C-5 fleet is 831 (minimum) and 1,188 (maximum) million
short ton-miles (STM)/year. We assumed priority cargo has the
first claim on this capacity and the economically eligible cargo
uses the remainder of the capacity. In FY 1964 508 million STM
were carried and we assume this for peacetime priority cargo
throughout 1970 to 1974.[1] This would leave 323 to 680 million
STM per year in June 1971. Capacity within the flying hour pro-
gram for economic cargo for the entire period is given on
Figure 3-3, based on the C-5 schedule in Figure 3-2. Projected
average total capacity, including that for priority cargo and
special missions, is given in Table 3-6.

---

[1]There is some overlap between priority and air mandatory
categories. For purposes of calculation, we have assumed the
508 million STM excludes all of the overlap.

FIGURE 3-3.   ASSUMED MAC CARGO CAPACITY FOR ECONOMIC AIR ELIGIBLE CARGO WITHIN FLYING HOUR PROGRAM
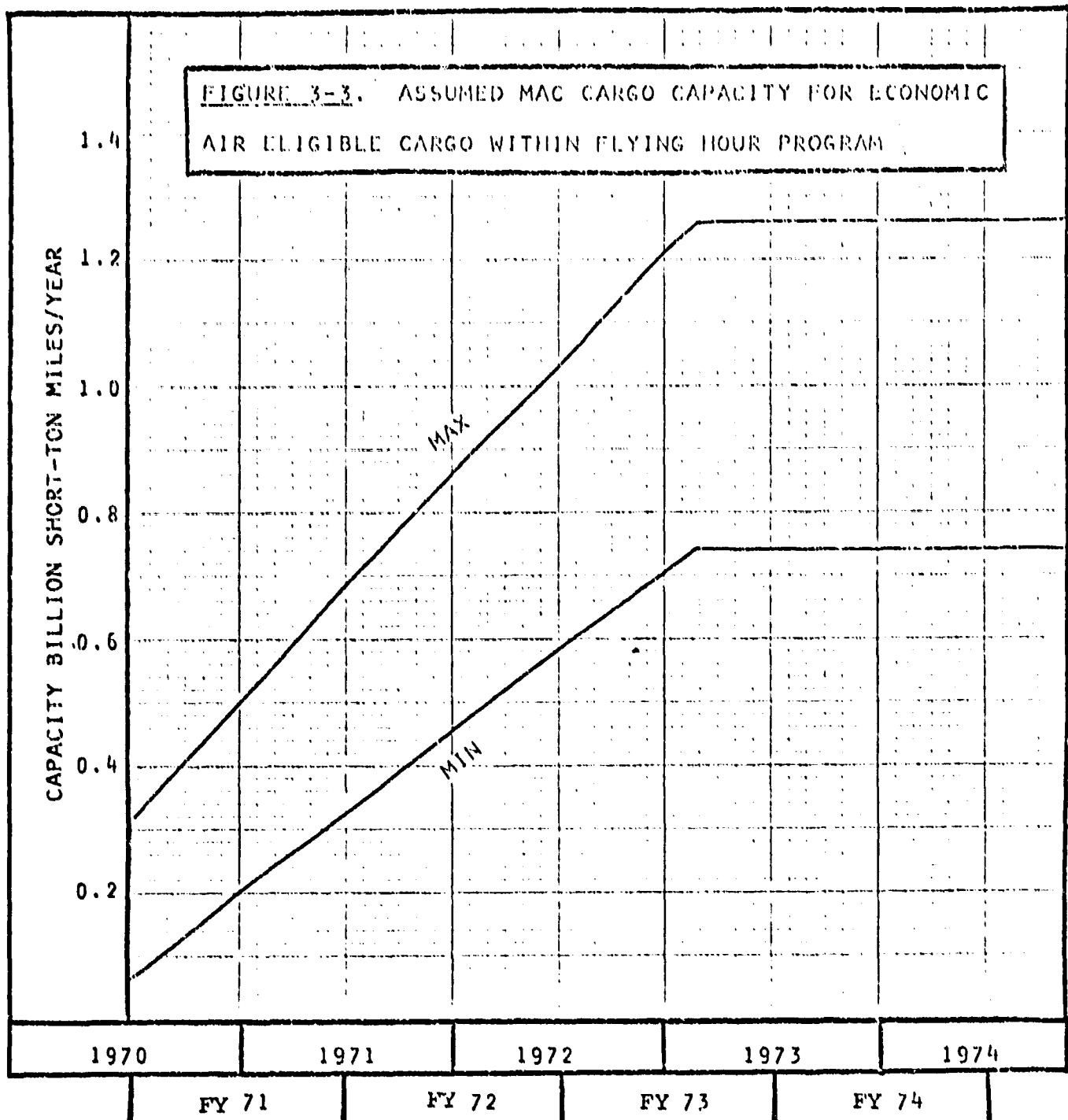
TABLE 3-6

CALCULATION OF ESTIMATED OUTBOUND FLYING HOUR PROGRAM CAPACITY

YEAR	CAPACITY IN MILLION SHORT-TON MILES				
	1970	1971	1972	1973	1974
Average of Maximum and Minimum Flying Hour Capacity[a]	187	501	810	1,000	1,000
Sum of Average and Priority[b]	695	1,009	1,318	1,508	1,508
Special Missions, etc.[c]	555	804	1,052	1,202	1,202
Total	1,250	1,813	2,370	2,710	2,710

[a] From Table 3-18, assuming 224 C-141s and schedule of C-5 as on Figure 3-2.

[b] Priority traffic assumed to be 508 million STM.

[c] Pro-rated: 2 hours of 4½ hour flying program is used for this item, as derived in footnote b of Table 3-4.

b. **Costs**

Within the flying hour program, cargo diversion to airlift increases vehicle operating and maintenance costs only to the extent that extra fuel is required for the extra weight, and extra wear occurs because of extra weight. To obtain the fuel costs, use was made of MAC "C-141 Fuel Planning Manual," MM55-20, 5 March 1969. Resulting values were about 0.38¢/ton-mile for fuel. Similar calculations for the C-5 were approximately the same. Analysis of budget data showed so-called "variable" costs were about 200% of fuel costs.[1]

_____

[1] IDA/WSEG, Op. cit., Vol. 2, p. 50.

Consequently, it was assumed that total incremental costs would range from 150% to 210% of incremental fuel costs within the training hour program. After taking into account the load efficiency, the incremental costs range from 0.74 to 1.04¢/STM.[1] These figures were assumed to apply throughout the period 1970 to 1974.

If cargo is airlifted over the capacity of the training hour program, costs must reflect the need for scheduling solely for such cargo. The daily cost to operate a C-5 3.5 hours per day is $11,899 and 10 hours per day costs $17,890.[2] The difference is $922/hour. This cost difference will support 35,100 STM, of which 77.5% x 50% (from Table 3-4) is effective outbound. Hence the cost is 6.75¢/STM. Corresponding calculations for the C-141 yields 13.42¢/STM. These values were assumed to have a possible 5% error. For June 1970, the costs are based entirely on C-141s and thus would be between 12.74 and 14.09¢/STM (13.42 ± 5%), as shown on Figure 3-4. For June 1971, the C-5s provide 31.1% of the MAC capacity.[3] Accordingly, the cost figures should be weighted by 31.1% for C-5 and 68.9% for C-141:

$$Cost = .311 \times 6.75 + .689 \times 13.42 = 11.34¢/STM$$

This June 1971 figure, ± 5%, also is plotted on Figure 3-4 as well as figures for subsequent years.

---

[1] For example, $0.74 = \dfrac{0.38 \times 1.5}{.775}$

[2] "MAC Projected C-5 Direct Operating Cost Factors," May 1970. Budget Division, Directorate of Industrial Funds, HQ, MAC.

[3] From Tables 3-4 and 3-5 we get $258 \div (573 + 258) = .311$.

FIGURE 3-4. ASSUMED INCREMENTAL AIRLIFT COSTS FOR CARGO ABOVE FLYING HOUR PROGRAM
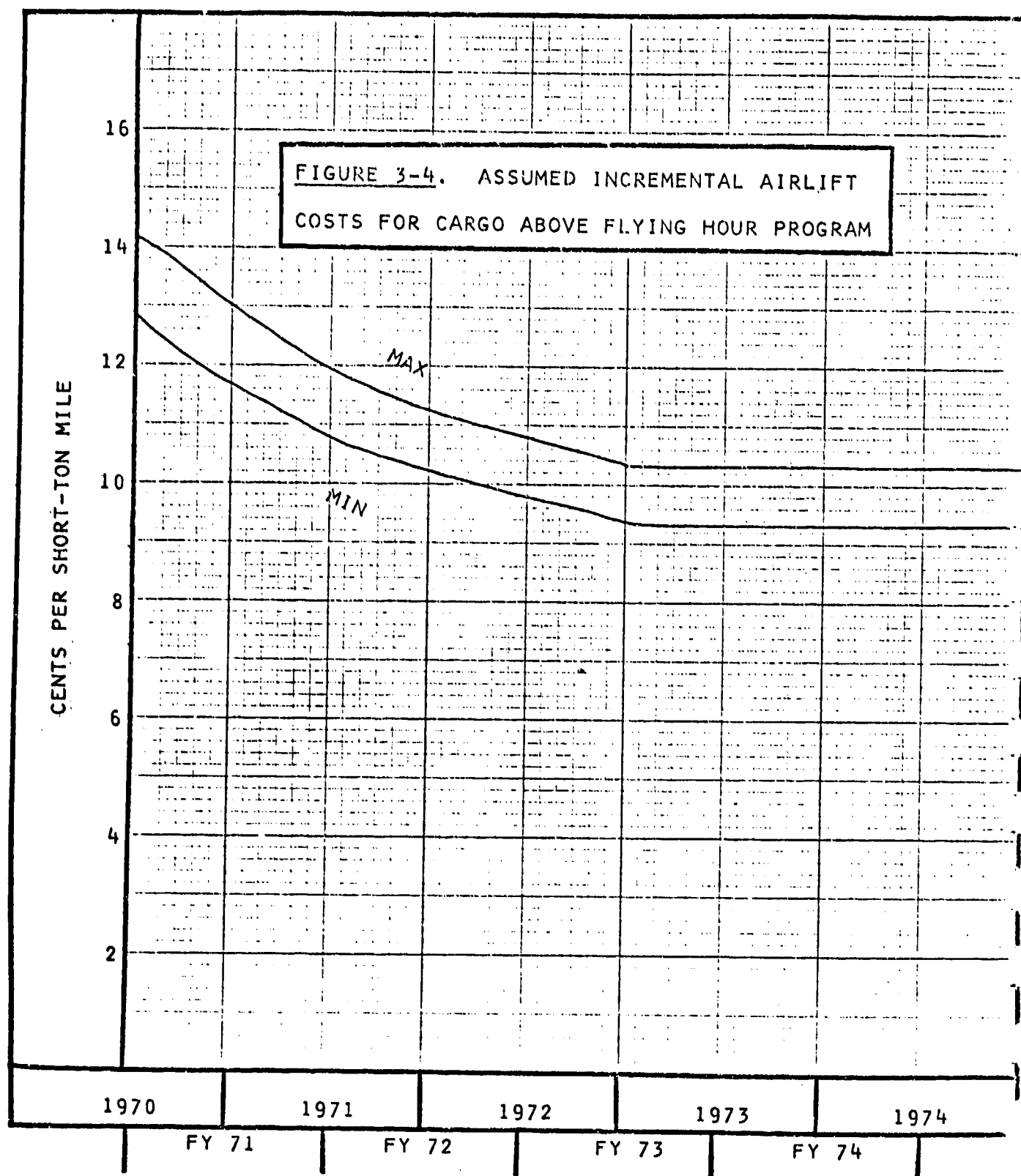
4.   Packing

Four independent factors complicate estimates of
packing cost:[1]

a.   the responsiveness of shipper-packers to the
method of shipment,

b.   the effect of shipping containers on packing
costs and packing cost differentials,

c.   the tendency to collect data by short tons in
airlift, and measurement tons in sealift, and

d.   the scarcity of data.

Accordingly, we took the data which seemed to reflect
the most comprehensive review, adjusted it to reflect varying
air-to-sea differentials to determine separate rates for airlift
and sealift, and then converted those figures for sealift to a
measurement ton basis. Details follow.

Calculations summarized in Table 3-7 from computer out-
put from the first RAC study showed that sealift packing costs
ranged from $20/ton to $88/ton.[2] Packing for airlift ranged
from $15/ton to $39/ton. As discussed earlier, we believe that
currently the packing costs often are not influenced by trans-
portation mode decisions. Therefore, we assumed none of the
packing costs were influenced by routine transportation mode de-
cisions in June 1970 and that in December 1974 packing practice
will be 100% responsive to routine transportation mode decisions
with a linear variation in between (Figure 3-5). We also

----

[1] By packing cost we refer to the outer wrap for shipment or
long-term storage under hostile environment as opposed to the
internal wrap usually provided by the manufacturer for storage
in a non-hostile environment.

[2] RAC R-64, Vol. 2, Table D17, p. 157, is an example.

TABLE 3-7

COST DATA FOR PACKING AND PORT HANDLING

Service	Assumed Break even Air Rate ¢/T-M _a/	Tons Air Eligible (thousands)	COSTS FOR AIR ELIGIBLE ITEMS ($ Thousands)			COSTS/TON ($)		
			Packing Cost Air	Packing Cost Sea	Port Handling Sea	Packing Cost Air	Packing Cost Sea	Port Handling Sea
Army	4	49.73	1,874	3,625	3,338	37.7	72.9	67.1
DSA	0	1,199.	17,833	23,569	27,174	14.9	19.7	22.7
AF	4	43.67	1,679	3,843	3,069	38.4	88.0	70.3
Navy	0	572.5	13,585	19,260	16,210	23.7	33.6	28.3
GSA	0	241.5	9,498	13,505	9,670	39.3	55.9	40.0

SOURCE: RAC-R-64 Computer Report #4.

_a/   : Data from lowest rate available used to maximize sample size.

assumed a linear decrease in all packing costs to 58% by December 1974 due to increased use of containers.[1] The product of the two lines in Figure 3-5 is the net responsiveness and is tabulated by date in Table 3-8.

---

[1] IDA study estimated container costs at 14% of break bulk port handling (Vol. 2, pp. 92 and 132). It also estimated an average of 55% would be amenable to containers (Ibid., Vol. 1, p. 46, average of 73 and 36). Assuming 90% can be aggregated in time to meet schedules:

58% = 90% x 55% x 14% + (1 - .90 x .55).

FIGURE 3-5. ASSUMED PACKING COST RESPONSIVENESS AND IMPACT OF CONTAINERIZATION ON PACKING COSTS
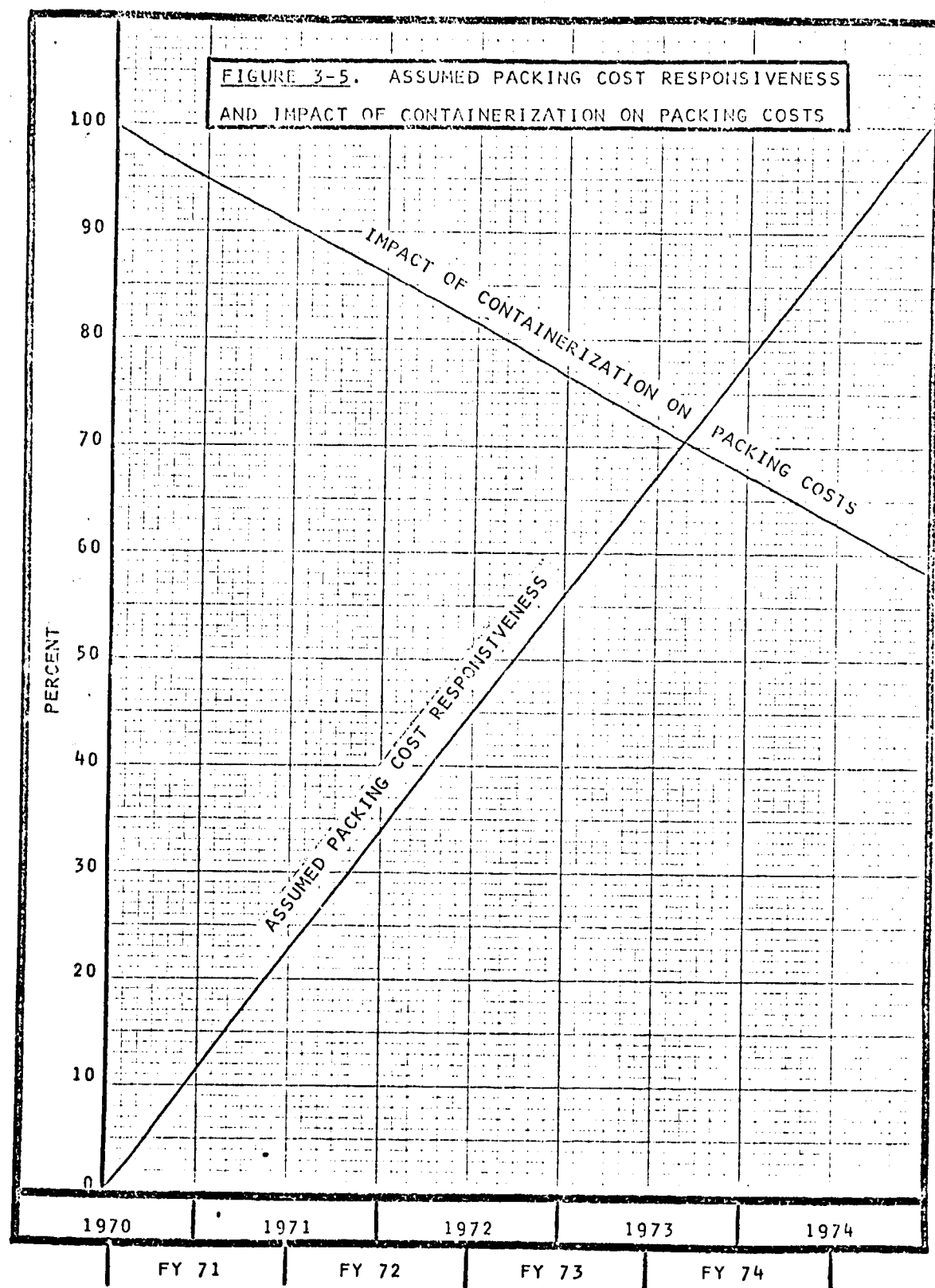
TABLE 3-8

FACTORS FOR PACKING COST

Date	% of theoretical packaging cost differences which actually occur
June 1971	20.1
June 1972	36.1
June 1973	48.0
June 1974	55.7

For each date the maximum and minimum packing costs were multiplied by the above. For example, the calculation:

$14.19/ton = $39.3/ton x .361

describes the maximum air packing cost in June 1972. This figure and those for other years are shown on Table 3-9.

TABLE 3-9

PROJECTED PACKING COSTS

	Packing Costs ($/Ton)			
	Sea		Air	
	Max.	Min.	Max.	Min.
June 1970	0	0	0	0
1971	17.72	3.97	7.92	3.00
1972	31.77	7.11	14.19	5.38
1973	42.26	9.46	18.87	7.15
1974	49.05	10.98	21.91	3.31

Source: Table 3-7 and 3-8. Max. and Min. figures of Table 3-7 multiplied by factors in Table 3-8. For example, 17.72 = 88.0 x .201.

5.   Port Handling

    a.   Se lift

Seaport (POE and POD) handling costs also are based primarily on data from the first RAC study, again because of convenience. RAC calculated port handling costs to range from \$23/ton to \$70/ton, depending upon the shipping agency.[1] These figures are used for June 1970. The figures for December 1974 were assumed to decrease to 58% (as calculated above) because of the trend to containers. The low limit was decreased by 10% and the high limit increased by 10% to account for increased uncertainty. The result for December 1974 is \$12/ton and \$45/ton. These costs are plotted on Figure 3-6.

    b.   Airlift

Aerial port handling charges are included in the air tariff, hence data are not as accessible as seaport data. MAC financial reports[2] show port handling costs from \$30.84/ton to \$53.52/ton, depending on what proportion of the staffing costs are assumed to vary with cargo handling. These costs were assumed to apply to June 1970 with a linear reduction to 58% ± 10%, or \$16.10/ton and \$34.15/ton, by December 1974 (see Figure 3-7).

6.   Total - Port Handling Plus Packing

We have assumed airlift port handling and packing costs are both proportional to weight and hence their sum determines the cost coefficient F_A of equation (7), Appendix 2.

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[1] This is also summarized on Table 3-7.

[2] Loc. cit.

FIGURE 3-6. ASSUMED AIRPORT HANDLING COSTS

FIGURE 3-7. ASSUMED AIRPORT HANDLING COSTS
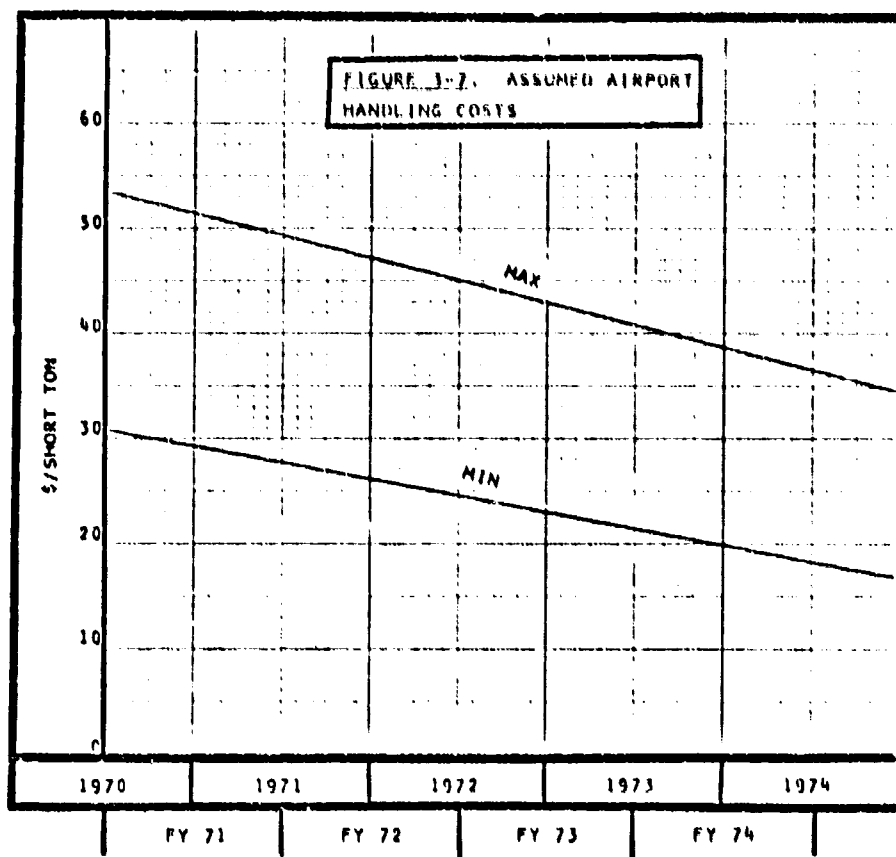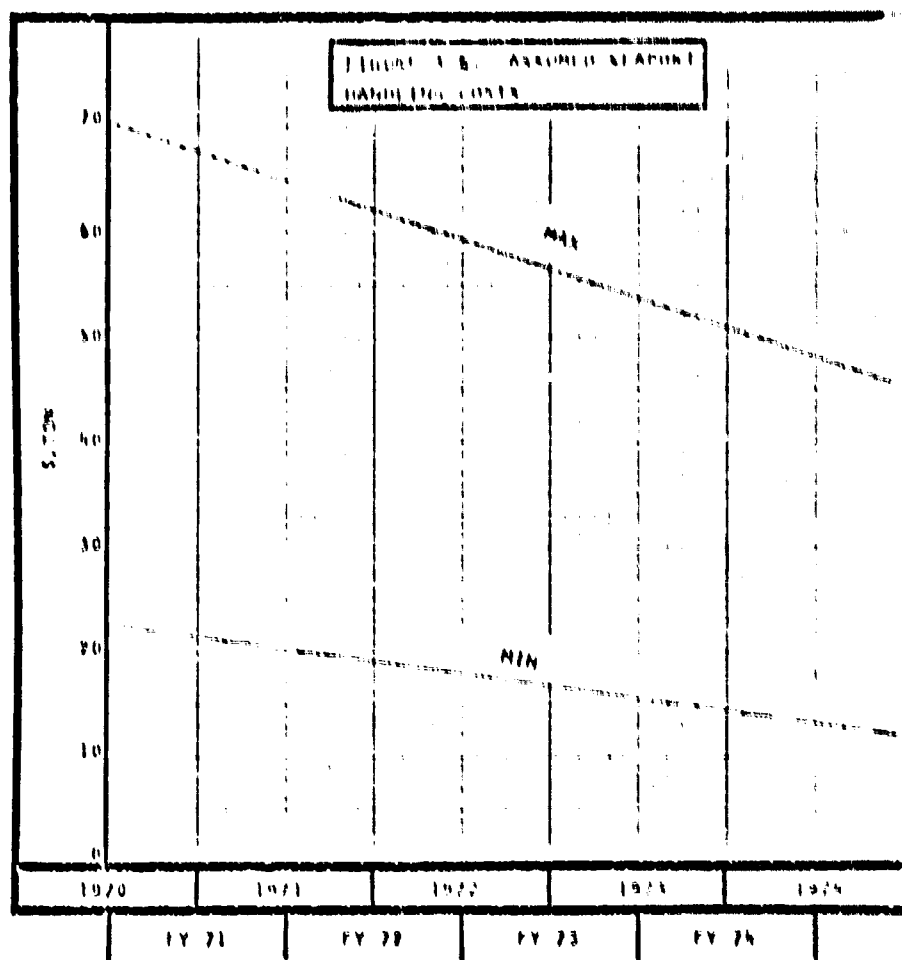
An illustrative calculation for maximum airlift cost in June 1971 is presented in Table 3-10.

TABLE 3-10

AIRLIFT COEFFICIENT ILLUSTRATIVE CALCULATION

Item	$/Ton	Source
Packing	7.92	Table 3-9
Port Handling	49.22	Figure 3-7
Total	57.14	Maximum June 1971 Airlift

Similarly, sealift port handling and packing costs have been assumed to be proportional to volume. Their sum determines coefficient G_s of equation (8) of Appendix 2. An illustrative calculation is shown in Table 3-11.

TABLE 3-11

SEALIFT COEFFICIENT ILLUSTRATIVE CALCULATION

Item	$/Ton	Source
Packing	17.72	Table 3-9
Port Handling	64.64	Figure 3-6
Total	82.36	Maximum June 1971 Sealift

These figures and those for other years are listed on Table 3-12.

TABLE 3-12

PROJECTED PACKING AND PORT HANDLING COSTS

	Costs ($/Short Ton)			
	Sea		Air	
	Max.	Min.	Max.	Min.
June 1970	70.30	22.70	53.52	30.84
1971	82.36	24.26	57.14	30.56
1972	90.75	24.99	59.11	29.66
1973	95.58	24.93	59.49	28.15
1974	96.71	24.04	58.23	26.03

Source: Table 3-9 and Figures 3-6 and 3-7.

Because the sealift figures are assumed proportional to volume,
they must be converted to $/cu.ft. The conversion factor used,
29.2 lbs./cu.ft., is derived from Table 3-2. Sealift packing
and port handling costs are summarized in Table 3-13.

TABLE 3-13

PROJECTED SEALIFT PACKING AND PORT HANDLING COSTS

	Costs ($/cu. ft.)	
	Maximum	Minimum
June 1970	1.03	0.33
1971	1.20	0.35
1972	1.33	0.36
1973	1.40	0.36
1974	1.41	0.35

Source: Table 3-12

7. **Inland Haul**

While estimates of inland haul costs, both in CONUS and overseas, ranged widely, in no case did the difference between the inland haul cost associated with sealift and airlift appear significant. Therefore, we ignored this factor in our calculations.

8. **Inventory Savings**

Inventory savings depend on two factors: the annual value of reduced inventory and the pipeline time saved by airlift. An additional relevant factor is the proportion of items whose Reorder Point (ROP) is responsive to the actual order and shipping time (O&ST).

a. **Value of Inventory Reduction**

If inventory is reduced, a one-time saving occurs, plus an annual saving due to having less of an item to manage and less obsolescence to deal with. A recent DoD instruction shows the following breakdown for the annual cost to hold inventory:[1]

Investment Cost = 10% of total value/year

Storage Cost = 1% of total value/year

Obsolescence = No factor given

Other Losses = No factor given

The AFLC study showed that reparable items in the Air Force inventory had a 6-year average life span and 11.4%/year obsolescence rate.[2] To be sure less stable items were considered, we

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[1] DoD Instruction 4140.39, "Procurement Cycles and Safety Levels of Supply for Secondary Items," 17 July 1970, Encl. 4, p. 3, para. II.E.

[2] AFLC, op. cit., Vol. 1, pp. 8-2 and 8-3.

arbitrarily used a five-year life for one calculation. The
investment cost amortized at 10%/year over five years is
26.4%/year. Since many items may be more stable, we also used
an arbitrarily higher figure of 10 years. The investment cost
amortized at 10%/year over 10 years is 16.3%/year. We assume
other losses at 1% and tolerance on the obsolescence rate of
± 30% of the base figure 11.4%. The resulting annual value of
inventory saving ranges between 26% and 43%, as given on Table
3-14.

TABLE 3-14

CALCULATION OF INVENTORY REDUCTION VALUE FACTOR

Item	% of Total Inventory Value Per Year	
	Maximum	Minimum
Storage Cost	1.0	1.0
Other Losses	1.0	1.0
Obsolescence (= 11.4 ± 3.4)	14.8	8.0
Amortization	26.4	16.3
Total	43.2	26.3

b. **Time Saving**

Airlift results in a shorter overseas pipeline.
The shortened pipeline is the principal element in the total
inventory reduction. In addition, a change in the safety stock
at the overseas depot may occur due to a change in O&ST vari-
ability. However, even if we assume a reduction in O&ST vari-
ability proportional to the reduced O&ST, the reduction in

safety stock is a small proportion of the pipeline reduction.
This conclusion follows because a relatively small quantity of
an item is required each month and the distribution most likely
is Poisson. Therefore, we ignored the effect of safety stock
changes. If and when improved data are available, this assump-
tion should be reviewed.

Pipeline time saved by airlift can be obtained
from several sources; three are given in Table 3-15.

TABLE 3-15

TIME SAVING BY AIRLIFT

Days	Source
22	RAC R-64
27	Sample of MSC records showed 31-day average round trip for 8,700 one-way route. Pro-rated to 5,240 miles (RAC data base).
39	UMMIPS (Northern Europe, Mediterranean, or Africa)

We assumed the times in Table 3-15 applied to June 1970 and that
the lower limit (22 days) would drop by one-third by December
1974 as a result of technological changes in the shipping indus-
try. The range of assumed time saved is plotted on Figure 3-8.
The product of time saved and value of inventory saved is tabu-
lated in Table 3-16. Linear variations between these limits
are given on Figure 3-9.

FIGURE 3-8. ASSUMED DAYS SAVED BY AIRLIFT

FIGURE 3-9. ASSUMED VALUE OF INVENTORY REDUCTION ALLOWED WHEN AN ITEM IS AIRLIFTED
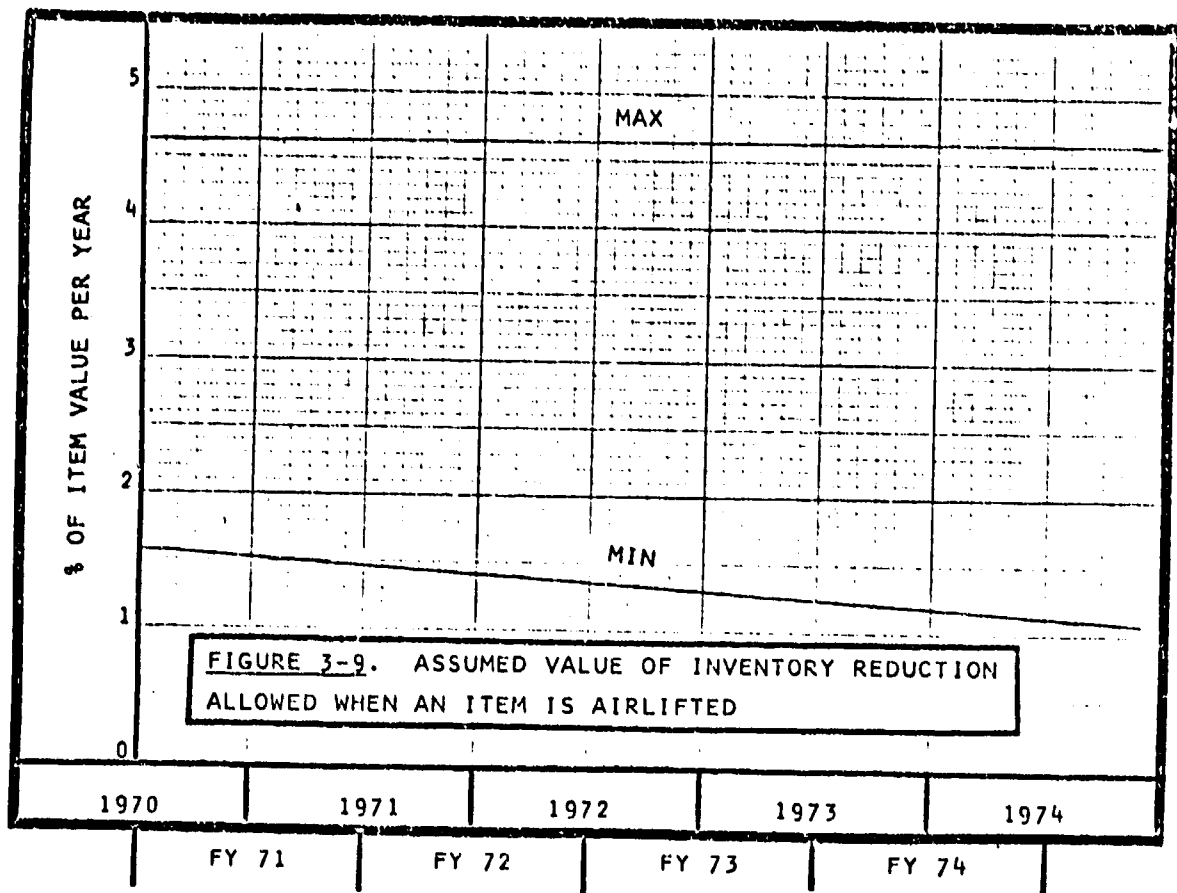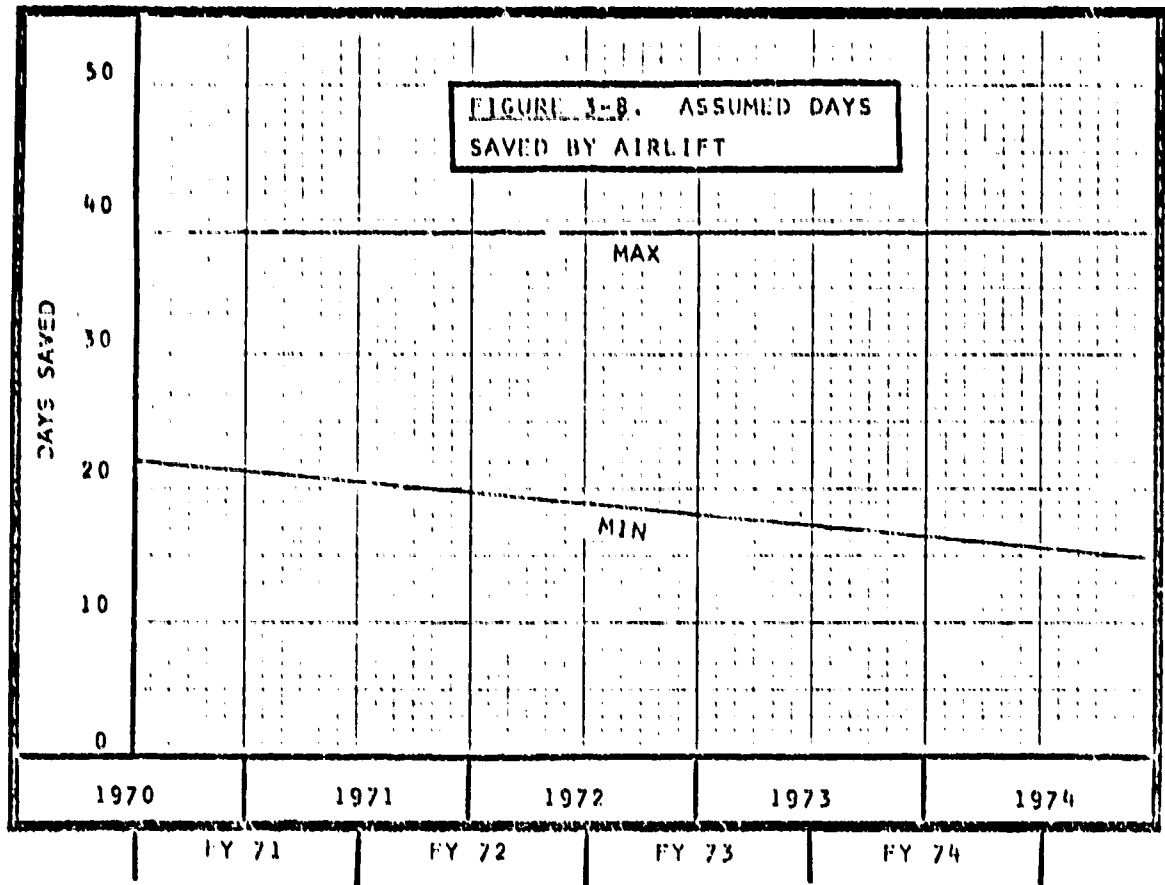
TABLE 3-16

VALUE OF INVENTORY REDUCTION DUE TO AIRLIFT

	% of Item Value	
	Maximum	Minimum
June 1970	4.61	1.59
December 1974	4.61	1.06

c.   Inventory Responsiveness to Airlift

As described earlier,[1] it was difficult to deter-
mine the proportion of items in overseas depots where ROPs
respond to actual O&ST and the proportion of overseas cargo
items in a buy position. Accordingly, we arbitrarily assumed
that in June 1970 the proportion of items in a buy position and
in responsive overseas depot systems ranged between 30% and 50%.
We arbitrarily assumed that by December 1974 this would improve
to between 70% and 95%. Figure 3-10 displays this.

C.   INPUT DATA SUMMARY

The calculations described in Section B are summarized in
this section under three categories: (a) data sources, (b) data
used for calculation of the air eligibility criteria, and (c)
data used for sensitivity or error analysis.

1.   Data Sources

A variety of sources are drawn upon for the input data.
Table 3-17 summarizes these sources two ways: (1) It shows what
figures or tables are used for each input datum LMI used in its

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[1] Pages 46 and 47.

FIGURE 3-10. ASSUMED PERCENT OF ITEMS IN DEPOTS WHERE REORDER POINT RESPONDS TO ACTUAL ORDER AND SHIPPING TIME
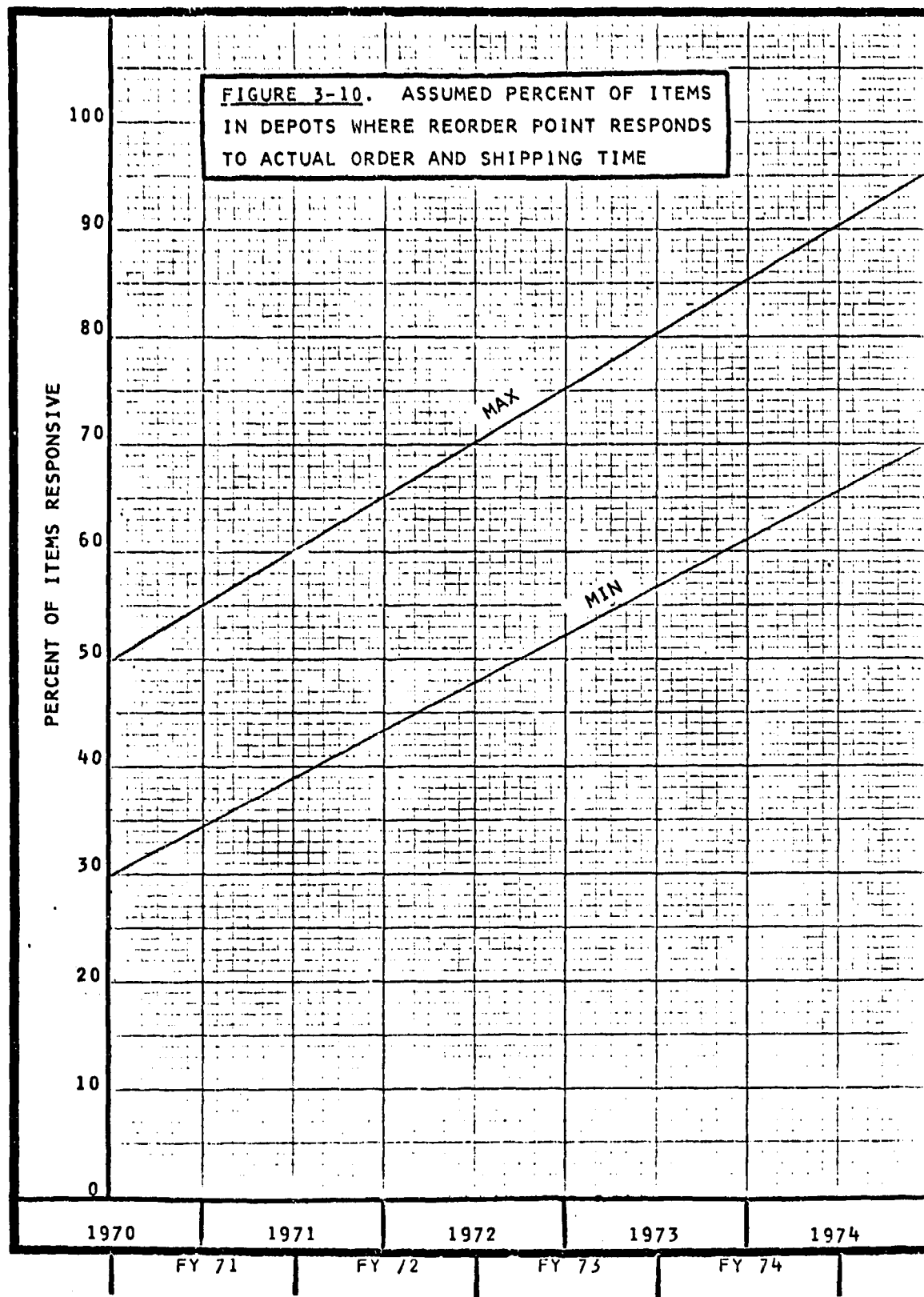
TABLE 3-17

INPUT DATA SOURCES

Data or Cost Factor	Source	
	Current LMI Calculations	DoD Component of Function which is likely Future Source
Peace Cargo Volume	Para B.1, p3-3	Supply
Ratio of War: Peace Volume	Para B.1, p3-4	Supply
Sealift Intercont. Rate	Fig. 3-1	MSC
Airlift Training Capacity	Fig. 3-3	MAC
Airlift Cost Within Training Capacity	Para B.3.b.	MAC
Distribution of Cargo Charact.	Table 3-2	Supply
Airlift Packing	Table 3-12	Supply
Sealift Packing	Table 3-13	Supply
Inventory Time Factor	Fig. 3-8	MTMTS
Inventory Cost Factor	Fig. 3-9	Supply
Inventory Responsiveness	Fig. 3-10	Supply
Inland Haul Costs		
CONUS	Not Used	MTMTS
O/S	Not Used	Supply
Airlift Port Costs	Table 3-12	MAC
Sealift Port Costs		
CONUS	Table 3-13	MTMTS
O/S	Table 3-13	Supply

calculation of the criterion, and (2) the table also shows the
DoD component or function likely to serve as the best source
in the future.

Most of the data are readily available. However,
three types of data are not: (1) cargo volume and character-
istics, (2) inventory cost factors and responsiveness, and (3)
packing costs. The first two types are very important, par-
ticularly in a transition period when historical patterns change
rapidly.

     a.   <u>Cargo</u>

Cargo volume and characteristics in war and peace,
estimated from individual item analysis, are essential for correct
air eligibility classification as well as for traffic management
and budgeting. Since projections from historical data can be
made and in view of the difficulty of obtaining cargo estimates--
requiring many man-years--it might appear fruitless to insist on
obtaining cargo data. However, it is not clear that historical
projections will be accurate enough, especially during transi-
tion from war to peace, as now. Moreover, many other planning
functions probably require those data, hence establishing an
improved data base in this area (probably synchronized with
the budget cycle), at least initially, seems inescapable.

     b.   <u>Inventory</u>

Accurate determination of inventory factors--unit
costs and possible pipeline reductions caused by airlift--is most
difficult. In fact, it is virtually impossible unless there is

accurate computation, for at least key items, of war requirements
and inventory alternatives. The cost for such computations is
enormous--easily many man-years--and perhaps would not be worth
the refinement as far as air eligibility alone is concerned.
However, inventory calculations or modeling are essential to the
efficient, responsive, management of commodities regardless of
airlift. For example, without such calculations there is little
assurance that mobilization requirements can be met regardless
of air eligibility. Accordingly, the information required for
accurate overseas transportation mode classification should
emerge from ongoing development of inventory management systems.

c. Packing

Enormous effort has been put into data collection
on packing costs by RAC, IDA/WSEG, and AFLC. Yet there is still
considerable uncertainty in the data. Moreover, packing costs
are a relatively small factor. Accordingly, LMI suggests that
DoD establish routine economic air eligibility first, and
then sample packing cost experience in the field to verify
what, if any, systematic data are needed.

2. Data for the Criterion

Calculations were made for each of five dates: June
1970, June 1971, June 1972, June 1973, and June 1974. For each
date calculations were made for two cargo volume extremes, viz.,
maximum and minimum airlift volume. The choice of upper or
lower range for each input datum was chosen to be consistent
with the extremes. For example, for the calculation of maxi-
mum airlift volume, airlift packing and port costs were set at
the minimum of their range, because this would favor airlift
over sealift. Table 3-18 summarizes those data.

TABLE 3-18

INPUT DATA FOR ELIGIBILITY CRITERIA

YEAR (June of Each Year) AIRLIFT CARGO[a]	1970		1971		1972		1973		1974	
	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN
Peacetime Cargo, Billion-STM	22.1	14.7	22.1	14.7	22.1	14.7	22.1	14.7	22.1	14.7
War:Peace Cargo Ratio	2.1	2.9	2.1	2.9	2.1	2.9	2.1	2.9	2.1	2.5
Sealift Rate, ¢/MTM	0.60	.478	0.6	0.413	0.6	0.348		.263	2.6	1.127
Airlift Ply. Prog. Cap. M-STM	310	65	680	323	1040	580	1265	745	280	745
Airlift Ply. Prog. Cost Rate,¢/STM	0.74	1.04	.74	1.04	0.74	1.04	.74	1.14	.74	1.14
Airlift Cost Above Ply. Prog.,¢/STM	12.74	14.09	10.77	11.907	5.78	11.78	5.36	11.75	5.36	11.75
Airlift Pack. & Port Cost, $/ST	30.84	53.52	30.56	57.14	25.66	59.11	28.15	53.49	26.13	58.23
Sealift Pack. & Port, $/SF	1.03	.33	1.20	.35	1.33	.36	1.46	.36	1.41	.24
Inventory Value, %	4.61	1.59	4.61	1.47	4.61	1.35	4.61	1.22	4.61	1.11
Inventory Response, %	50.0	30.0	60.0	38.5	70.2	67.8	82.2	56.7	90.1	65.5

[a] The inputs under the columns headed "MAX" have been set at the extreme of the range shown in the text and previous figures and tables which maximized airlift cargo ton-miles. Similarly the inputs under the columns headed "MIN" have been set at the extreme which minimized airlift.

One calculation was made using the mid-range value of each input datum to obtain the June 1971 value of the air eligibility criterion. The mid-range input datum is shown on Table 3-19 under the column headed "Best Estimate."

3. Sensitivity

A series of sensitivity calculations were made using the "Best Estimate" as a reference. First, we perturbed inventory responsiveness to see the impact of a supply system more responsive to actual OST. Second, all other variables (as a group) were perturbed halfway to the limit used for maximum airlift ("+50%" on Table 3-19) and then halfway to the limit used for minimum airlift ("-50%") to see the effects of data uncertainty as a group. Lastly, each variable was individually perturbed halfway to its upper limit. Table 3-19 summarizes the input data used in our sensitivity analysis.

D. OUTPUT

The output from the criterion calculations (corresponding to Table 3-18 input) are given in Table 3-20. The results of the sensitivity calculations are given in Table 3-21 and a ranking of the cost factors by their relative influence on the air eligibility criterion, amount of savings and air cargo volumes appears on Table 3-22.

Data uncertainty of most of the factors affects the air eligibility criterion and the amount of the saving. However, the list of those inputs which affect the number of FSCs suggests that only a few of the factors, primarily the inventory factors, actually change the identity of those items to be declared air eligible; but the calculations are complicated by the uncertainty of the other factors.

TABLE 3-19

INPUT DATA FOR SENSITIVITY ANALYSIS, 1971

	"Best Estimate"	Full Inv. Response	Sensitivity of All Parameters as a Group +50%[a]	Sensitivity of All Parameters as a Group -50%[b]	KTM Cargo	War:Peace Ratio	Sealift Rate	Airlift Fly.Prog. Capacity	Air Rate Within Fly.Prog. Prog.	Air Rate Above Fly.Prog. Prog.	Air Pack.	Sea Pack.	Inv. Value	Inv. Resp.
Peacetime Cargo, Billion-STM	16.4		20.3	16.6	20.3									
War:Peace Cargo Ratio	2.5		2.3	2.7		2.3								
Sealift Rate, ¢/MBM	.506		.55	.46			.55							
Airlift Fly. Prog. Cap. M-STM	501.5		591	412				591						
Airlift Fly. Prog. Cost Rate, ¢/STM	.69		.815	.965					.815					
Airlift Cost Above Fly. Prog., ¢/STM	11.34		11.05	11.62						11.05				
Airlift Pack. & Port Cost, $/ST	43.85		37.2	50.5							37.2			
Sealift Pack. & Port, $/ST	.775		.99	.56								.99		
Inventory Value, %	3.04		3.03	2.36									3.03	
Inventory Response, %	49.4	95	54.7	44.1										54.7

Note: All vacant entries have the values of corresponding entries in the "Best Estimate" column.

[a] Each input is half way between value under "Best Estimate" here and "TAB" of 1971, Table 3-18.

[b] Each input is half way between value under "Best Estimate" here and "TAB" of 1971, Table 3-18.

TABLE 3-20

OUTPUT DATA TABULATION—AIR ELIGIBILITY CRITERION

Item	June 1970 Max.	June 1970 Min.	June 1971 Max.	June 1971 Best Est.	June 1971 Min.	June 1972 Max.	June 1972 Min.	June 1973 Max.	June 1973 Min.	June 1974 Max.	June 1974 Min.
c/T-M at Optimum	6.44	2.85	6.51	4.24	2.18	5.80	1.34	7.01	1.26	7.41	1.16
Inventory Savings, $ Million	79	8	100	47	14	124	16	142	18	158	18
Savings, $ Million	92	9	135	61	17	180	20	214	20	231	19
Air Traffic Million-STM	310	65	680	591	323	1040	580	1260	700	1250	985
c/T-M at Inv. Saving Limit	13.05	12.72	9.95	6.82	3.59	8.81	2.83	9.05	2.43	9.36	2.38
Inv. Saving, $ Million	78	7	100	44	13	120	16	138	17	155	17
Savings, $ Million	85	8	113	49	14	144	17	168	18	192	17
Air Traffic, Million-STM	189	22	324	201	111	495	200	600	254	531	255
$/lb at Optimum	3.87	9.00	1.74	1.47	3.85	1.47	3.85	1.47	3.74	1.47	3.85
Savings, $ Million	83	8	126	54	14	152	17	178	17	157	18
Traffic, Air, Millions-STM a/	234	62	678	590	167	851	205	973	257	1094	282
$/lb at Inv. Saving Limit	7.66	21.0	3.87	3.87	4.86	3.34	3.85	3.13	3.85	3.73	3.86
Inventory Savings, $ Million	76	7	100	44	13	122	16	141	17	154	18
Savings, $ Millions	82	7	112	48	13	143	16	167	17	182	17
Air Traffic, Millions-STM	171	22	324	201	111	497	200	500	254	500	255

The outputs correspond to the input data of Table 3-18.

a/ Optimum traffic volume generated by $/lb criteria often did not fill the flying hour program because of a flat curve. For example, for the "Min" column of June 1971, 323 million short ton-miles corresponded to $1.42 lb and a saving of $13.7 million; a reduction of only $0.5 million from the optimum shown.

TABLE 3-21

OUTPUT DATA FOR SENSITIVITY ANALYSIS, 1972

| | "Best Estimate" | Full Inv. Response | All Parameters | | INDIVIDUAL SENSITIVITY Of Input Parameters As Shown | | | | | | | | | |
			+50%	-50%	PCM Cargo	War:Peace Ratio	Sealift Rate	Airlift Fly.Prog. Capacity	Air Rate Within Flying Prog.	Air Rate Above Flying Prog.	Air Pack.	Sea Pack.	Inv. Time	Inv. Resp.
C/T-M at Optimum	4.24	4.60	5.35	3.21	4.40	4.24	4.46	4.19	4.24	4.24	4.25	5.01	4.24	4.25
Savings, $ M	60.6	93.8	93.6	35.6	64.5	61.0	61.6	64.5	60.5	60.6	61.1	64.3	7.1	64.5
Air Traffic, M-STM	501	501	591	412	501	501	501	591	551	551	551	551	551	5C1
Number of FSC at Inv. Limit Point	128	99	132	126	128	128	127	128	128	128	128	126	135	125

These outputs correspond to the input data of Table 3-19.

TABLE 3-22

ESTIMATED RELATIVE INFLUENCE ON OUTPUT

June 1971

¢/Ton-Mile Air Eligibility Criterion at Optimum	Maximum Saving	Air Eligible Cargo Volume	Number of FSC's at Inventory Limit Point
Sealift Pack & Port Handling	Inventory Value	Airlift Capacity	Inventory Value
Sealift Rate	Airlift Capacity		Inventory Response
Peacetime Cargo Volume	Peacetime Cargo Volume		Sealift Rate
Airlift Pack & Port Handling	Inventory Response		
Airlift Capacity	Sealift Pack & Port Handling		
Inventory Response	Sealift Rate		
Inventory Value	Airlift Pack & Port Handling		
	War: Peace Cargo Ratio		
	Airlift Rate		

First item affects column heading the most for the individual sensitivity variation shown on Table 3-19. Based on Table 3-21.

E. **OPERATING COST CALCULATIONS**

Fleet operating costs for a 4½ hour flying program in June 1971, if no revenue cargo was carried, are arbitrarily based on budget figures cited in Table 3-23.

TABLE 3-23

ANNUAL OPERATING COST CALCULATION

Description	Calculation	
Aircraft Type	C-141	C-5
Daily Cost, 4½ hour flying program[a]	$2,826	$5,447
Annual Cost/Aircraft, $Millions	1.031	1.988
Number of Aircraft Assumed	224	27
Annual Cost, $Millions	231	54
Fleet Cost, $Millions	285	

[a]Interpolated from "MAC Projected C-5 Direct Operating Cost Factors," May 1970, Budget Division, Directorate of Industrial Funds, Hq. MAC.

The projected tariffs are figured in Table 3-24 for full use of the flying hour program capacity. Table 3-25 derives the tariffs for 0, 40, and 100% use of the capacity available for economic cargo.

TABLE 3-24

CALCULATION OF FY 1971 TARIFF

Description	Value
Priority Cargo, M-STM	508
SAA, EX/ABT etc.[a/], M-STM	805
Total Capacity, M-STM	1813
Extra Cost @ .89¢/STM, $Million	16
Ratio: Reimbursable ÷ Direct Operating Cost	
C-5	75.8
C-141 %	63.7
Weighted Ratio[b/]	66.0
Fleet Cost, Reimbursable[c/], $Million	188
Capacity, M-STM[d/]	500
Total Cost = 188 + 16, $Million	204
Tariff = Total Cost ÷ Total Cap. ¢/T-M	11.2

Source: Table 3-19 ("Best Estimate"), Table 3-23 and MAC Ibid.

    a/ Prorated: (2 hrs ÷ 2.5 hrs) x (500 + 508) = 805.

    b/ $\frac{231}{285}$ x .637 + $\frac{54}{285}$ x .758 = .66; 285 from Table 3-23.

    c/ 285 x .66 = 188.

    d/ From Table 3-19, rounded from 501.5.

TABLE 3-25

TARIFF SENSITIVITY CALCULATION

Description	Values		
% Use by Economic Cargo	0	40	100
Cargo Volume[a/], MSTM	1313	1513	1813
Extra Cost[b/] $ M	12	13	16
Total Cost[c/] $ M	200	201	204
Tariff[d/] ¢/T-M	15.2	13.3	11.3

Source: Table 3-24

a/ (% x 500) + 1313, where % is from first line

b/ $\dfrac{\text{Cargo volume} \times 16.}{1813}$

c/ 188M + Extra Cost

d/ Total Cost ÷ Cargo Volume

APPENDIX 4

SUGGESTED CHANGES TO DoD DIRECTIVES

CONTENTS

APPENDIX 4

iii

APPENDIX 4

SUGGESTED CHANGES TO DoD DIRECTIVES

A. **INTRODUCTION**

This Appendix includes drafts of new, or modifications to existing, DoD Directives and Instructions. These drafts are designed to permit and encourage use of the economic criterion presented in the body of the report. Drafts are presented for:

- DoD Directive 4500.9, "Transportation and Traffic Management"

- DoD Instruction 4410.6, "Uniform Materiel Movement and Issue Priority System"

- DoD Instruction (New), "Air Shipment Mandatory Criteria Values for Fiscal Year ____"

B. **CHANGES TO: DoD DIRECTIVE 4500.9, 27 SEPTEMBER 1968, WITH CHANGE 2, 10 OCTOBER 1969**

DoD Directive 4500.9 contains general policies for the use DoD-owned transportation capability. In order to implement the use of an economic airlift criterion, it is suggested that changes to the Directive be made as follows:

1. Add to the references: (h) DoD Instruction 4410.6, "Uniform Materiel Movement and Issue Priority System (UMMIPS).

2.   Add to paragraph IV. C. 1, after second sentence:
The technique presented in Enclosure 2 will be used whenever:
(a) a new item is to be brought into the DoD supply system (pro-
visioning), and (b) procurement of an item is to be made and the
item is presently routinely shipped from CONUS by sealift.

3.   Add to paragraph V, after the first sentence: The
procedures presented in Enclosure 2 shall become effective upon
issuance of a DoD Instruction specifying a value for the economic
airlift criterion.

4.   Add an Enclosure 2 to DoD Directive 4500.9, outlining
how the economic criterion is to be used. A suggested draft
Enclosure is contained in the following pages.

(Suggested Draft Enclosure 2 to DoD Directive 4500.9)

USE OF AN ECONOMIC CRITERION FOR DETERMINING INTERCONTINENTAL MODE OF TRANSPORTATION

I.   INTRODUCTION

The use of an economic criterion to determine the mode of intercontinental transportation for DoD routine cargo can improve the cost effectiveness of the DoD, considering the DoD distribution system as a whole (procurement, inventory management, storage, requisition, issue, and transportation). The choice of transportation mode influences the worldwide inventories of goods that must be maintained to have a responsive logistics system. Therefore, an economic criterion for choice of mode assists in achieving the proper level of inventories.

Most items in the DoD supply system are stocked on the basis of using sealift for the intercontinental transportation. If such items were routinely transported by airlift the inventories could be reduced, thereby reducing procurements. In some cases the reduction in procurement does not compensate for the increased airlift costs. Moreover, for many items, inventory should not be reduced regardless of transportation mode because of mobilization reserve requirements and wartime resupply considerations. As a result it is necessary to develop rules and procedures for accurately determining what items routinely should be shipped via airlift and those via sealift. This enclosure presents the criterion to be used, the data and calculations required to develop such criterion and the assignment of responsibilities to implement the criterion. It is assumed that priority cargo continues to be airlifted regardless of this criterion.

The criterion which determines the best mode of transportation considers all portions of the DoD distribution costs. To realize the maximum benefits from the criterion each individual, office, and agency concerned must follow the procedures and assignments as presented. Anomalies should be brought promptly to the attention of the Office of the Assistant Secretary of Defense (I&L).

(Suggested Draft Enclosure 2 to DoD Directive 4500.9)

11. PROCEDURE

The procedure of designating items as economically air mandatory involves five sequential steps described below:

A. DATA COLLECTION

The following data are required to calculate the air eligibility criterion:

1. Volume (short ton-miles) and characteristics (price density, density, weight) of the peacetime overseas cargo demand, by FSC or FSN, expected for the following year, for outbound and retrograde each separately.

2. Ratio of the wartime overseas cargo volume (short ton-miles) to the peacetime volume.

3. Average sealift intercontinental haul rate (cents/measurement ton-mile) adjusted for average net volume.

4. Airlift overseas peacetime outbound channel capacity (short ton-miles) within the   orized flying hour program after   .uction for training, special missions, airborne exercises, circuitous routing, peacetime priority cargo, and load factor.

5. Airlift intercontinental incremental costs (cents/short ton-mile) to fly outbound channel cargo increments within the authorized flying hour program, adjusted for average net weight.

6. Packing costs for the average airlift item ($/short-ton).

(Suggested Draft Enclosure 2 to DoD Directive 4500.9)

7. Aerial port handling costs for the average airlift item ($/short-ton). These costs should be the average incremental cost, i.e., the difference between DoD expenses if there was no economic cargo and the expense if there was full use of channel capacity, divided by the capacity.

8. Packing costs for the average sealift item ($/cubic foot).

9. Seaport handling costs for the average sealift item ($/cubic foot).

10. Ratio of average annual cost to maintain inventory to the value of the inventory. The annual cost will include:

   a. Amortization of purchase cost using the interest rate specified in DoDI 7041.3 and life of the average item in the inventory system;

   b. storage costs specified in DoDI 4140.39, Encl 4, para. II E;

   c. obsolescence costs specified in DoDI 4140.39, Encl 4, para. II E, based on life of the average modification in the inventory; and

   d. other losses specified in DoDI 4140.39, Encl 4, para. II E.

11. Average difference between overseas shipment/delivery time for airlift and sealift or alternatively average reduction in O&ST possible at O/S depot. Proportion of theoretical inventory reduction actually achieved world wide for average item airlifted.

(Suggested Draft Enclosure 2 to DoD Directive 4500.9)

12. Proportion by tonnage of items shipped overseas that are in a supply system able to respond to actual O&ST reductions without reducing readiness and are in a "buy" or "repair" position. (In other words, the proportion of tonnage of potentially air eligible overseas shipments that are air mandatory.)

13. Airlift incremental costs for cargo beyond the flying hour program capacity.

B. RANKING ITEMS REQUIRED OVERSEAS

The expected peacetime overseas cargo demand items should be ranked by $/lb. starting with the highest value first.

C. CALCULATION

The cost to airlift, Z_A, and sealift, Z_S, each item in the ranked demand list will be calculated in order, using the formulas below. If only a sample of items is available, the total volume will be assumed to have the same distribution as the sample.

$$Z_A = F_A \times W + M \times D_A \times \max\ (W, V/200) \tag{1}$$

$$Z_S = G_S \times V + M \times E_S \times \max\ (W, V/40) + J \times \Delta t \times P \tag{2}$$

where F_Z = Air Packing and Port Handling Cost, $/ton

W = Weight of Item shipped in one year, tons

M = Length of Intercontinental Shipping Distance, miles

D_A = Airlift Rate, $/ton-mile

V = Volume of Item shipped in one year, cubic feet

G_S = Sea Packing and Port Handling Cost, $/cubic foot

E_S = Sealift Rate, $/measurement ton-mile

(Suggested Draft Enclosure 2 to DoD Directive 4500.9)

J = Cost to Hold and Amortize Item, % of item
price/year saved by airlift

Δt = Time Saved by Airlift, years

P = Price of the Amount of an Item Shipped in one
year, $

The estimated peacetime airlift volume of the items
in the ranked list will be cumulated in order, taking
into account the proportion of items able to respond to
O&ST (II.A.12). Wartime airlift will also be cumulated
in order using the ratio of war to peace traffic
(II.A.2). The break-even rate, D, will be calculated as:

$$D = \frac{Z_S - F_A \times W}{W \times M} \qquad (3)$$

In calculating Z_S from Equation (2), the inventory
element, $(J \times \Delta t \times P)$, will be considered zero for those
items in the ranked list below the item where the cumu-
lated wartime airlift exceeds the flying hour program
capacity and break-even rate, D, is less than the airlift
cost above the flying hour program (II,A.13) or the cumu-
lated wartime airlift exceeds the flying hour program and
D equals the airlift cost above the flying hour program.
The price density ($/lb.) will be noted.

The calculation process will be terminated when the
peacetime airlift total exceeds the flying hour program
airlift capacity. The price density at this point is the
air eligibility criterion. Expected peacetime traffic
will correspond to the selected price density.

The criterion for shelf life items will be adjusted
as follows: All items in condition code C (DoD Instruction
4140.27, "Identification, Control and Utilization of Shelf-
Life Items," 12 September 1968) are air mandatory. Those
items in condition codes B or A with two or less years of

shelf life remaining will be air mandatory if their price
density equals or exceeds that value obtained by adjust-
ing the price-density ($/lb.) figure--call it Y--obtained
above, by the expression:

$$X = Y \times J \times t_1 \tag{4}$$

where X = the criterion in $/lb. for a shelf-
life item

Y = the criterion in $/lb. for other items

J = cost to hold and amortize item as de-
fined above

t_1 = shelf life of item in years

D. CRITERION

The air eligibility criterion, price density
($/lb.) from above, plus the break-even rate, expected
peacetime airlift and sealift traffic, expected savings
and the ratio of the product of break-even rate times
average intercontinental airlift distance to the time
saving (II.A.11), will be issued. The price density
will be used for item classification. The break-even
rate may be used instead of price density by those DoD
components able to do so and with permission of ASD
(I&L). Peacetime traffic estimates will be used for
transportation planning and evaluation of system
operation.

E. ITEM CLASSIFICATION

Each item or family of interchangeable items
in the supply system whose price density equals or exceeds
the air eligibility criterion will be examined for the
following:

(Suggested Draft Enclosure 2 to DoD Directive 4500.9)

1. Is it to be procured or repaired in
   the planning period?

2. Are the overseas depots stocking the
   item responsive to actual O&ST?

3. Can the overseas stock be reduced
   without impairing readiness or can
   readiness and capability be improved
   by airlift?

If the answer is yes to all three, then the item
is declared air mandatory. This examination will also help
supply inventory-saving data (II.A.11) required for future
calculations.

For each item already classified air mandatory
but which no longer meets the above requirements, the cost
of extra procurement and reclassification will be deter-
mined. If this cost exceeds the extra airlift cost for the
remaining item life, there should be no reclassification.
If the cost does not exceed the extra airlift cost, the
item should be reclassified. An alternate procedure is to
increase the item price-density by the ratio that the extra
procurement and reclassification costs bear to the cost of
required additional inventory. Then if the adjusted price-
density is below the criterion, the item should be reclassi-
fied. Only "air mandatory" items are to be airlifted rou-
tinely.

III. RESPONSIBILITIES

To implement the concept and procedures above, the follow-
ing assignment of responsibilities is made.

A. The Assistant Secretary of Defense for Installations
and Logistics (ASD I&L) shall:

1. Designate a point of contact for all mat-
   ters relating to the economic criterion
   for determining the mode of intercon-
   tinental transportation.

(Suggested Draft Enclosure 2 to DoD Directive 4500.9)

2. Revise all related DoD Directives and In-
structions to permit and encourage the use
of an economic criterion.

3. Issue such one-time and periodic instruc-
tions as are required to keep the criterion
current and of maximum value to the DoD.
In May of each year a new criterion value
will be issued for use during the next
fiscal year or until revised.

4. Using the data submission from the com-
ponents, calculate a new criterion value
for the next year in April.

5. Review and analyze the data available and
procedures to determine if:

a. The criterion or the procedures need
to be modified.

b. Other portions of the distribution
system (other than the intercontinental
leg) can be modified to obtain greater
savings, and

c. Effective and economic utilization is
being made of the DoD transportation
resources.

B. The Secretaries of the Military Departments shall:

1. Designate a point of contact for all
matters relating to economic criterion
for determining the mode of intercontinental
transportation. This point of contact shall
have available all appropriate data and in-
formation to insure proper and effective use
of the criteria.

2. Revise appropriate current Department Direc-
tives and Instructions to permit and encour-
age the use of an economic criterion.

(Suggested Draft Enclosure 2 to DoD Directive 4500.9)

3. Issue the criterion values as promulgated by DoD Instruction to all persons, offices, and agencies involved in determining the intercontinental mode of transportation of DoD cargo.

4. Execute the steps enumerated in Section II.E. above for all items in the DoD supply system under their control or procured from DSA or GSA. These steps will be repeated each time a new criterion value ($/lb.) is issued.

5. Declare all items that meet the specifications of Section II.E. above to be "air mandatory" and insure that all such shipments are airlifted.

6. Advise all involved in shipping of an item what the routine transportation mode is.

7. Review and revise the procedures of the Shipping Service Clearance Offices to permit and conform with the principle and procedures of economic criterion.

8. Maintain records to be the source of the required data and to be the basis for evaluations.

9. Collect, process, and submit to the OASD (I&L) in February or upon request the following data:

   a. Volume (short ton-miles) and characteristics (value density, density weight) of the peacetime overseas cargo demand by FSC or FSN, expected for the following year, for outbound and retrograde, each separately.

   b. Ratio of the wartime overseas cargo volume (short ton-miles) to the peacetime volume.

   c. Packing costs for the average airlift item ($/short ton).

(Suggested Draft Enclosure 2 to DoD Directive 4500.9)

     d.   Packing costs for the average sealift item ($/cubic foot).

     e.   Ratio of average annual cost to maintain inventory to the value of the inventory.

     f.   Average difference between overseas shipment/delivery time for airlift and sealift or alternatively average reduction in O&ST possible at overseas depot. Proportion of theoretical inventory reduction actually achieved worldwide for average item airlifted.

     g.   Proportion by tonnage of items shipped overseas that are in a supply system able to safely respond to actual O&ST reductions and are in a "buy" or "repair" position.

     h.   The overseas seaport handling costs for the average sealift item ($/cubic foot).

  10.   Report all anomalies caused by the use of an economic criterion for mode determination promptly to the OASD(I&L).

    C.   The Single Manager for Ocean Transportation shall collect, process, and submit to the OASD(I&L) in February or upon direction the average sealift intercontinental haul rate (cents/measurement ton-mile) adjusted for average net volume. Expected peacetime sealift traffic will be used for planning purposes.

    D.   The Single Manager for Airlift Services, shall:

    1.   Designate a point of contact for all matters relating to an economic criterion for determining the mode of intercontinental transportation. This point of contact shall have available all appropriate data and information to insure proper and effective use of the criterion.

(Suggested Draft Enclosure 2 to DoD Directive 4500.9)

2. Maintain records to be the source of the required data and to be the basis for evaluation.

3. Collect, process, and submit to OASD(I&L) in February or upon request the following data:

    a. Airlift overseas wartime and peacetime outbound and retrograde capacity (short ton-miles) within the authorized flying hour program after deductions for training, special missions, airborne training, circuitous routing, peacetime priority cargo, load factor, and risk.

    b. Airlift intercontinental incremental costs (cents/short ton-mile) to fly outbound channel cargo increments within the authorized training hour program, adjusted for average net weight.

    c. Airlift incremental costs for cargo beyond the flying hour program capacity.

    d. Aerial port handling costs for the average airlift item ($/short-ton).

    e. Actual airlift cargo volume for preceding period by the following categories: outbound priority, outbound air mandatory, both of the preceding, morale, and retrograde.

4. Evaluate the use of the criterion to insure that maximum benefits are being obtained.

5. Use expected peacetime airlift traffic for planning purposes.

6. Report all anomalies caused by the use of an economic criterion for mode determination promptly to the OASD(I&L).

(Suggested Draft Enclosure 2 to DoD Directive 4500.9)

E.   The Single Manager for Military Traffic, Land
Transportation, and Common-User Ocean Terminals, shall:

1.   Maintain records to be the source of the
required data and to be the basis for
evaluations.

2.   Collect, process, and submit to the OASD(I&L)
in February or upon request the CONUS seaport
handling costs for the average sealift item
($/cubic foot).

C.   CHANGES TO: DoD DIRECTIVE 4410.6, FEBRUARY 18, 1971

To implement and permit the use of an economic air eligibility
criterion, a number of changes to UMMIPS are necessary. Basically,
our suggested changes modify the system only to the extent of per-
mitting a Required Delivery Date (RDD) that is based on the eco-
nomics involved in the distribution of material. Our suggested
changes are:

1.   Add paragraph I.C.5. to Enclosure 1 as follows: Air
Mandatory: The designation given to an item in the DoD supply
system that is economic to ship routinely via airlift.

2.   Add paragraph VI.B.3.a.(4) to Enclosure 1 as follows:
The item has been declared "Air Mandatory" and worldwide inven-
tories have been adjusted to reflect the Order and Shipping
Times (O&ST) for airlift transportation. Failure to meet the
RDD so determined will cause overseas depots to dip into safety
stocks and submit high-priority requisitions.

3.   Add paragraph VII.C. to Enclosure 1 as follows:
Materiel whose stock record indicates that the item is "Air
Mandatory" will be returned from overseas via airlift irrespec-
tive of the Priority Designator. If regular airlift is not
adequate, expedited sealift will be used.

D. SUGGESTED DRAFT OF NEW DoD INSTRUCTION STATING CRITERIA VALUES

DEPARTMENT OF DEFENSE INSTRUCTION

Subject: Air Eligibility Criteria Values for Fiscal Year 1972

Ref: (a) DoD Directive 4500.9, "Transportation and Traffic Management" 27 September 1960

I. PURPOSE This instruction issues the Air Eligibility criteria values to be used in determining the mode of intercontinental transportation to be used for shipment of materiel in the DoD distribution system.

II. APPLICABILITY AND SCOPE The provisions of this instruction apply to all DoD components and to all items in the DoD distribution system. The provisions also apply to all new items entering the system whether during provisioning or initial procurement.

III. POLICIES

A. The air eligibility criterion value to be used except for shelf-life items during Fiscal Year 1972 or until revised is $3.87 per pound.

B. The air eligibility criterion value to be used for shelf-life items during Fiscal Year 1972 or until revised is given in the following schedule:

Suggested Draft of New DoD Instruction Stating Criteria Values

Shelf Life Code	Shelf Life Period, Months	Criterion, $/lb.
D	4	0.17
E	5	0.21
F	6	0.26
G	7	0.30
H	8	0.34
J	9	0.38
K	10	0.43
L	11	0.47
1	12	0.51
M	13	0.56
N	14	0.60
P	15	0.64
Q	16	0.69
R	17	0.73
S	18	0.77
T	21	0.90
2	24	1.03
All others	25-120	1.47

    C.   The peacetime sealift traffic expected from use of the current air eligibility criterion is 33.5 billion measurement ton-miles/year.

    D.   The peacetime outbound routine resupply airlift traffic expected from use of the current air eligibility criterion is 200 million short ton-miles/year.

    E.   The current break-even rate for airlift is 6.82 cents/ton-mile. The ratio of the product of the break-even rate times average airlift distance to time saved by airlift is $13 per ton-day.

    F.   Any retrograde traffic whose price density is between $3.87/pound and $ .75/pound may be designated as air mandatory at the option of the Service Departments.

    G.   The procedures presented in Enclosure 2 of reference (a) will be followed in using these criteria values.

(Suggested Draft of New DoD Instruction Stating Criteria Values)

IV.   RESPONSIBILITIES

The heads of all DoD components shall:

A.   Insure that the criteria value specified in this instruction are promptly circulated as appropriate.

B.   Insure that the criteria values are properly used as directed by the referenced enclosure.

C.   Insure that transportation requirements and budgets are adjusted to reflect the traffic expected from use of the criteria values.

D.   Insure that all of their portions of the DoD distribution system react to the new criterion values and include it in all appropriate determinations.

E.   Report all savings when using the criteria.

F.   Report to the OSD(I&L) anomalies that develop which are caused by the use of the criteria.

V.   EFFECTIVE DATE AND IMPLEMENTATION

A.   This instruction is effective the first day of the designated fiscal year.

B.   Appropriate DoD component directives, instructions, and manuals will be issued or modified and distributed prior to the effective date.